DOCUMENT RESUME

ED 234 085 TM 830 587

AUTHOR Dangel, Timothy R.
TITLE A Design for Evaluating and Reporting the Effectiveness of a School System Developed Science Curriculum.
INSTITUTION Anne Arundel County Public Schools, Annapolis, Md.
PUB DATE Apr 83
NOTE 57p.; Paper presented at the Annual Meeting of the American Educational Research Association (67th, Montreal, Quebec, April 11-15, 1983).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Elementary Secondary Education; *Evaluation Methods; *Models; *Program Effectiveness; *Program Evaluation; School Districts; *Science Curriculum
IDENTIFIERS *Anne Arundel County Public Schools MD

ABSTRACT

This evaluation report describes the process by which a large urban-suburban school system evaluated a locally developed, systemwide, kindergarten through grade 12 science program and the results of the evaluation. The evaluation was based upon a set of broad evaluation questions related to three components of the science program: (1) the science curriculum, (2) student performance in and attitudes toward science, and (3) science instruction. Although the evaluation focused on the science curriculum, the design is applicable to other curricula. The design for answering the questions provided for both internal and external evaluations and for the collection of both new information and the aggregation of existing information. The final report was organized to meet the information needs of a variety of audiences by summarizing all data under the evaluation questions. The value and importance of the model are that it is manageable, can be implemented by a small staff, uses standardized and locally developed instruments, produces a report of results which is comprehensive yet understandable by a lay board of education, and fosters the use of evaluation results for ongoing program refinement and improvement. (PN)

**********
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
**********

ED234085

# A DESIGN FOR EVALUATING AND REPORTING THE EFFECTIVENESS OF A SCHOOL SYSTEM DEVELOPED SCIENCE CURRICULUM

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

A Paper Presented at the National Conference
of the
American Educational Research Association
Montreal, Canada, April 11-15, 1983

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

T. R. Dangel

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Presented by:

Dr. Timothy R. Dangel
Coordinator of Research

ANNE ARUNDEL COUNTY PUBLIC SCHOOLS
2644 Riva Road
Annapolis, Maryland

Printed in U.S.A.

TM 830 787

A Design For Evaluating And Reporting The Effectiveness Of A School System Developed Science Curriculum

TIMOTHY R. DANGEL, Anne Arundel County Public Schools

Timothy R. Dangel, Coordinator of Research
Anne Arundel County Public Schools
2644 Riva Road
Annapolis, MD 21401

This paper reports the process by which a large, urban-suburban school system evaluated its science program. The objective of the paper is to outline and describe the steps by which the evaluation was initiated, designed, implemented, and reported and the procedures developed to address and implement the evaluation findings and recommendations. Although the evaluation focused on the science curriculum, the design is applicable to other curricula.

The school system, a large, urban-suburban school district of 119 schools, implemented a kindergarten through grade twelve unified science curriculum in 1972. After ten years of using this instructional program, a series of questions were raised by the superintendent of schools, board of education, and science staff relevant to the effectiveness of this locally developed science program. The questions related to three components of the science program: the science curriculum (i.e., "Are the cognitive elements, skills, and processes addressed by the current science curriculum appropriate to produce students with scientific literacy in the decade of the 1980s?" "Is the science curriculum consistent with current theories of learning and instruction?"); student performance in and attitudes toward science (i.e., "What is the students' knowledge of science content and processes?" "Does the science curriculum meet the needs of special students?"); and science instruction (i.e., "To what degree has the unified science curriculum been implemented in the schools?" "What preparation do teachers need to teach unified science?").

A set of evaluation procedures was designed to answer these questions. The evaluation design provided for gathering information from five sources:

1. Consultants external to the system examined the curriculum and responded to a set of questions about the unified science curriculum. They also produced a set of recommendations. The consultants were contracted from a set of individuals nominated by the American Association for the Advancement of Science, The National Science Teachers Association, and the Federation for Unified Science Education.

2. Students who had graduated from the school system over the previous five years were surveyed about their current education or employment status, the degree to which their science education was used daily and/or on the job, and their attitudes toward science and their science education.

3. All school principals, science department chairpersons, and science teachers received a survey about unified science and responded to questions regarding inservice needs; the degree to which unified science was implemented in their classrooms; instructional strategies used to teach science; materials used

to plan and deliver instruction; the availability of curriculum materials, textbooks, and equipment; and the effectiveness of the unified science program.

4. A random sample of students was tested on their knowledge of general science in grades four, six, and nine. A sample of students was selected from high school general biology, chemistry, and physics courses and was administered a standardized achievement end of course biology, chemistry, or physics test.

5. Information related to the evaluation questions which already existed was assembled from a variety of sources: cumulative records, student schedules, student test results, Middle States evaluations of high school science programs, teachers' lesson plans, teacher made tests, and Scholastic Aptitude Test reports.

The final report of the evaluation was organized to integrate and synthesize data from each of the above sources under the original questions which initiated the evaluation design. This format provided in one document both comprehensiveness and clarity. Readers of the report had access to either the entire evaluation or to specific questions of interest. Under each evaluation question, findings were keyed via a set of codes to one of the twelve sources of data. Finally, the evaluation findings were summarized; observations about trends, consistencies, and inconsistencies in the data were noted; and a set of recommendations from consultants and the staff were offered.

A component of the evaluation process was to foster the use of the evaluation report to effect changes in the science program where necessary. The report was made available or presented formally to the board of education, science department chairpersons, citizens advisory committees, the curriculum and science offices, and at four public reaction sessions. These various audiences were surveyed on their reactions to a series of proposed changes in the science curriculum and its delivery proposed by the science office after receiving the evaluation report. Several changes have been effected in the science program to date; the changes were initiated by the evaluation.

This evaluation model provides for the evaluation of programs developed by individual school systems. The evaluation was comprehensive, provided for both internal and external evaluators, and provided for both the collection of new information and the aggregation of existing information. The value and importance of the model is that it is manageable, can be implemented by a small staff, uses standardized and locally developed instruments, produces a report of results which is comprehensive yet understandable by a lay board of education, and fosters the use of evaluation results for ongoing program refinement and improvement.

# SCIENCE PROGRAM EVALUATION

FINAL REPORT

Submitted by the Office of Research,
Timothy R. Dangel, Coordinator

## INTRODUCTION

### I. MODEL FOR EVALUATING CURRICULUM PROGRAMS

A model designed to evaluate curriculum programs was presented to the Board of Education in November 1980. This model provided for the evaluation of three phases of a program: the curriculum; implementation of the curriculum; and student performance, attitudes and later success. The model provided a comprehensive view of a program which went beyond the scope of evaluation models previously used. Within each phase of the model (the curriculum, instruction, student data) a series of broad research questions were generated to guide the evaluation design. Finally, the model was implemented for the first time with the science program. The development of this model and all phases of this evaluation were reviewed monthly by the school and program evaluation committee.

### II. BROAD RESEARCH QUESTIONS

The following questions were used as primary guidelines for the development of the evaluation design. The questions were answered by collecting information from five sources: consultants, survey of the staff, survey of former students, test scores, and other data which had already been collected within the system.

#### A. THE SCIENCE CURRICULUM

- Are the cognitive elements, skills, and processes addressed by the current science curriculum appropriate to produce students with scientific literacy in the decade of the 1980's?
- Does the science curriculum allow students to organize their knowledge based on previous knowledge and experiences?
- Is the science curriculum consistent with current theories of learning and instruction?
- Does the science curriculum match the developmental characteristics of students at each grade level?
- Are the demands made upon the teachers to implement the science curriculum reasonable?
- Are the suggested activities for each Unified Science Proficiency Level Objective (PLO) appropriate to reach the objective?
- Does the science curriculum meet the diverse needs of students?
- Are adequate equipment and materials of instruction available for science instruction?
- Do classroom science facilities support the existing curriculum?

#### B. THE STUDENT - PERFORMANCE, ATTITUDES, AND LATER SUCCESS

- What are the characteristics of secondary students who schedule unified science and the various semester and year science courses?
- What is the students' knowledge of science content and processes? What are the students' attitudes toward science?
- Does the science curriculum meet the needs of special students (e.g., the gifted/talented/advanced of special education student)?
- What are the attitudes toward the science program of graduates who are pursuing science and non-science careers?

#### C. SCIENCE INSTRUCTION

- To what degree are the unified science curriculum and semester and year secondary science courses implemented K-12?
- What preparation do teachers need to teach the unified science curriculum? What are teacher staff development needs to support science instruction?

- What are the instructional strategies and techniques currently used to teach science?
- What steps do teachers believe are necessary to improve the delivery of the science curriculum?

## III. PROCEDURES FOR THE EVALUATION

The broad research questions were the basis for generating a set of more specific questions to be asked of consultants, staff, former and present students. The specific methods for gathering each type of information are listed below:

### A. CONSULTANTS

One of the major components of the evaluation was the use of external specialists as consultants to examine the science curriculum. From a list of names submitted by the staff, the Foundation for Unified Science Education, National Science Teachers Association, and American Association for the Advancement of Science, six consultants were contracted.

The consultants were selected to represent a breadth of expertise in science education, science curriculum development, unified science, elementary science, secondary science, and theories of learning and instruction. In addition four of the six consultants worked within an hour travel to Annapolis to minimize evaluation costs for travel, food, and lodging.

The six consultants were:

| | |
|---|---|
| Mr. Joseph Dasbach | American Association for the Advancement of Science Washington, D.C. |
| Dr. Francis J. DiVesta | Department of Counseling and Educational Psychology, Penn State University |
| Dr. Bernard Gross | Director of Science, Rochester Public Schools |
| Mrs. Constance Tate | Coordinator of Science, Baltimore City Public Schools |
| Dr. Leon Ukens | Department of Physics, Towson State University |
| Dr. J. David Lockard | The International Clearinghouse on Science and Mathematics Curriculum Developments, University of Maryland |

Each of the first five consultants was sent a list of questions to address and a set of representative K through 12 curriculum materials to examine (Attachment A). Following their examination of the materials, the consultants independently addressed the questions in a written report. On August 24, 1981, the consultants met in Annapolis for one day. At that time, following a presentation and discussion of the five reports, Dr. Lockard wrote one final overview synthesizing the strengths of, weaknesses of, and recommendations for the science curriculum. This final report comprises the bulk of the "Research Questions Related To: The Science Curriculum" in the Results portion of this evaluation report.

### B. SURVEY OF FORMER STUDENTS

The cumulative records of Anne Arundel County Public School graduates between 1976 and 1980 were sampled by examining every twenty-fifth record. The student's name, address, program, science courses, and earned science credits were recorded from each record. This survey of cumulative records and recording of science program information was compiled by two retired Anne Arundel County Public School guidance counselors. The science records of 737 students were recorded, keypunched, and analyzed. The specific analyses of this information are presented in greater detail under "Other Data Available: Cumulative Records" of the Procedures.

A survey was developed to reflect the research questions under Study Area B (Student Performance, Attitudes and Later Success) and Study Area C (Instruction) and was mailed to 729 former students whose records had been sampled. The addresses of 8 records were unclear, missing, or incomplete. Of these 729 surveys, 122 were undeliverable by mail, and one former student was deceased. Surveys were returned by 158 students (153 were usable). The composition of this sample of graduates is as follows:

| | | | |
|---|---|---|---|
| 1. Males | 56 | Females | 96 |
| 2. Current Status: | | | |
| Employed full-time | 51% | College Graduate | 7% |
| Employed part-time | 28% | Military | 6% |
| Enrolled in Post Secondary Ed. | | Homemaker | 8% |
| Junior or Community College | 12% | Unemployed | 8% |
| Trade, Technical or Business School | 7% | Other | 11% |
| Four year college | 30% | | |

Of those graduates who are currently employed, seventeen percent had a science related job and forty-nine percent had a non-science related job.

Job relatedness to science was determined by asking former students the nature of their employment and matching their responses with a listing of science related careers/employment. For nine percent of the surveys the determination of science- non-science employment was not possible from the response; the remaining twenty-three percent of the former students did not answer this item.

A copy of the Survey of Former Students is found as Attachment B. The results from this survey are reported in the Results section of this report.

C. SURVEY OF STAFF

A survey was developed to be completed by the schools' staffs to reflect questions from all three areas of the evaluation model. Surveys were sent to all principals, science department chairpersons, and unified science teachers. Surveys were returned by 568 staff members. These surveys represent 36 principals, 30 science department chairpersons, 480 teachers, and 22 not coded by position. A copy of the Staff Survey of Unified Science is attached (Attachment C). Results of the survey are found in the Results section of this report.

D. ACHIEVEMENT TEST SCORES

The evaluation design provided for standardized achievement test administration in science. Science achievement tests were reviewed by the Coordinator of Research, School and Program Evaluation Committee, and Science Materials of Instruction Committees. The Sequential Tests of Educational Progress (STEP) (Addison-Westley, 1978) were selected for the following reasons: The tests are up-to-date, they focus on science processes in addition to science knowledge, they were favorably reviewed by the science staff as matching the county science curriculum, they were developed by Educational Testing Service, and they provided tests for general science as well as for courses in high school. Thus the test was the most up to date instrument which appeared to provide a representative survey assessment of science achievement in the student population.

The original design for testing specified administering general science tests in grades 4, 6, 8 and 10 and end of course tests in biology, chemistry, and physics. The STEP does not provide norms for grade 10. Therefore, the design was modified to test in grade 9 and to eliminate testing in grades 8 and 10.

A desirable feature of student testing was to test enough students to provide a representative sample of students while keeping the testing demands in schools to a minimum. The following random sampling technique was used.

General Science

Grade 9. All senior high schools with a ninth grade and junior high schools were sent a listing of 25 students randomly selected from the total school ninth grade enrollment. Principals were asked to eliminate any special education students (level 04 or higher), any student who had been absent during the year for more than 15 days, and students who had not been in Anne Arundel County Schools for the last nine years of their education. This assured that the effect of unified science would be reflected in test scores. From the students' names that remained on the list, principals were asked to test the first eight students on the list. This random selection procedure insured that all students not eliminated by the procedures specified above had an equal opportunity to be chosen for testing.

Grades 4 and 6. A similar procedure was used to select eight sixth grade students from all middle schools and eight elementary schools. Students in grade four were sampled from 16 elementary schools (four randomly chosen from each area).

End of Course Tests

Using procedures similar to general science testing, course enrollment listings for each senior high school were used to randomly select 25 students each in biology, chemistry, and physics. Biology students were selected from General Biology (C26000) and the BSCS Biology courses. Chemistry students wre selected from General Chemistry (C45000); physics students were selected from General Physics (C55000) or PSSC Physics (C58000). No advanced biology, chemistry or physics students were sampled for testing. Principals were asked to eliminate any special education student at service level 04 or higher, any student who had been absent for more than 15 days, or any student who had not completed the entire course in Anne Arundel County Public Schools. From the names remaining on the list, principals were asked to administer the appropriate end of course test to the first ten students listed.

The parents of all students tested were informed of the testing and student results were returned to schools.

The following numbers of students in each grade/end of course were tested:

| | | |
|---|---|---|
| General Science - | Grade 4 - | 128 |
| | Grade 6 | 135 |
| | Grade 9 | 117 |
| End of Course - | Biology | 114 |
| | Chemistry | 114 |
| | Physics | 101 |

E. OTHER AVAILABLE DATA

In addition to collecting the types of information described above, additional data was already available. This data was assembled and is included in the Results section which follows. The data consists of:

1. Cumulative Records. Cumulative records were pulled for 737 students who had graduated from Anne Arundel County Public Schools between 1976 and 1980. Their academic program, the science courses which they had elected, and the number of credits earned in science were keypuncher and analyzed. These 739 students represent the following high school programs:

| | |
|---|---|
| Academic | 257 |
| General | 202 |
| Commerical | 185 |
| Vocational | 55 |
| Unknown | 38 |

2. Ability Achievement Test Scores/Scheduling Data. Ability and reading and mathematics achievement test scores were examined for students in each science course during the 1980-81 school year. Test scores were available for 6155 senior high school students in science courses in grades 10 through 12. The creation of this information provides for the examination of the average ability and/or achievement of students enrolled in each secondary science course as well as the range of achievement and ability in each course. These patterns are reported in the Results section.

3. Middle States Evaluations. Every ten years senior high schools undergo a year of self-evaluation as well as evaluation by a visiting team. This process and the meeting of specified criteria is required for school accreditation. One of the areas examined in this process is the science program (including science facilities). Middle States evaluation data on the science program was requested from all senior high schools which had undergone Middle States evaluation in the last five years. This data was gathered to examine science facilities and high school semester elective courses, thus reducing the number of requests for information made to the schools. Data from Middle States is included in the Results section of this report.

4. Lesson Plans. Three lesson plans were requested from each of the elementary schools which participated in testing. The lesson plans received were added to lesson plans provided by the Acting Coordinator of Science from his file. These plans were examined to determine the types of learning outcomes teachers emphasize in lesson plans. Three hundred thirty-eight objective statements from 101 lesson plans spanning grades K to 12 were examined. From each plan the verbs from the objectives were tallied (e.g., discuss, learn, use). The frequencies of these learning outcomes were then categorized by Bloom's Taxonomy of Learning Outcomes.

5. Teacher Made Tests. Principals of junior and senior high schools were requested to send one copy of each science semester exam. Semester exams are required in all subjects taught in grades 9-12. One hundred fifty-eight exams were received. The tests received in unified science 9 and 10, biology, chemistry and physics were examined. Each test item was categorized according to Bloom's Taxonomy of Learning Outcomes. A total of 6,891 items were thus classified. It must be noted here that these classifications were made solely on the basis of the test items. It is very difficult to classify a test item without knowing what content was presented to students prior to testing. The following test items were examined; the results are included later in this report.

| Subject Area | Number of Tests | Number of Test Items |
|---|---|---|
| Unified Science 9 | 11 | 2989 |
| Unified Science 10 | 8 | |
| Biology | 30 | 3137 |
| Chemistry | 16 | 530 |
| Physics | 15 | 235 |

6. Scholastic Aptitude Test Scores. Each year approximately 1,500 students take the Scholastic Aptitude Test prior to application to college or for consideration for scholarships. A smaller number of students elect to take achievement tests in specific content areas. In science achievement tests may be taken in biology, chemistry, and physics. These achievement test results are included in the Results.

7. The Ten Year Plan for Educational Excellence. During the 1979-80 school year a team of classroom teachers wrote a plan to direct education in the Anne Arundel County Public Schools during the decade of the 1980's. The data and recommendations produced by that plan are included where they interface with specific research questions.

8. Other data. Additional data has become available through a variety of pathways: letters from science teachers or departments, and discussions with the Acting Coordinator of Science and other staff members involved in the implementation of unified science. This information is included in the Results of this report.

## IV. ANALYSIS OF THE DATA

The responses of staff and students on the various surveys were coded onto machine scannable forms; the data from cumulative records was keypunched. Survey and cumulative records data were analyzed by the various statistical programs available through data processing. Briefer sets of information such as the teacher-made tests and lesson plans were hand tabulated and analyzed in a similar fashion. All tests were hand scored; test means were hand calculated. Analyses produced the frequency and percentage of respondents for survey items and provided for the comparison of responses among various groups (e.g., elementary, middle, junior and senior high school teachers). These results as well as a summary of all comments and open-ended questions are reported in the next section of this report.

Source of Data

## RESULTS

The results of the consultants, surveys, tests, and other data are summarized under the broad research questions which guided their development. Each research question will be followed by a narrative and/or tabulated summary of the results, observations, and comments. To the right of each narrative or table will be a series of codes which relate each summarized finding to the source of the data. The codes are:

| | | |
|---|---|---|
| C | = | Consultant |
| PDT | = | Survey of Staff (Principals, Department Chairpersons, Teachers) |
| FS | = | Survey of Former Students |
| AT | = | Achievement Tests |
| CR | = | Cumulative Records |
| TSD | = | Test/Scheduling Data |
| MS | = | Middle States Evaluations |
| LP | = | Lesson Plans |
| TMT | = | Teacher-Made Tests |
| SAT | = | Scholastic Aptitude Test Results |
| TYP | = | 10-Year Plan Data |
| CS | = | Computer Scheduling for the 1981-82 School Year |

In addition, a number following the codes PDT or FS refers to the specific item on the survey.

### I. THE SCIENCE CURRICULUM

**NOTE:**

Research questions A through H related to the science curriculum were addressed by each consultant. For organizational purposes and ease of reading, the consultants' specific comments have been reordered and integrated with all other relevant data so that each research question can be addressed separately. Consultants' comments are reprinted verbatim and are noted with an asterisk (*). In order to communicate the final report of the consultants in its entirety as a separate, external component of this evaluation, the "Synthesized Summary of Consultant's Reports" submitted by Dr. David Lockard is reprinted as Attachment D.

Additionally, copies of the individual consultant's reports are available by request from the Department of Research and Evaluation. Copies of the individual consultant's reports are available to Board of Education members in the Board Conference Room.

A. ARE THE COGNITIVE ELEMENTS, SKILLS, AND PROCESSES ADDRESSED BY THE CURRENT SCIENCE CURRICULUM APPROPRIATE TO PRODUCE SCIENTIFICALLY LITERATE STUDENTS DURING THE DECADE OF THE 1980's?

**Results:**

1. Unified Science approach strengths: C

*a. It provides a systematic approach to program development and reflects an immense organizational effort of an academically and technically capable staff dedicated to excellence.
*b. The scheme for scientific literacy is a good starting base for a total science program.
*c. The basic constructs and philosophical roots detailed in the first eight pages of the taxonomy are excellent beginnings and when properly implemented provide highly desirable directions.
*d. The format as designed will facilitate revisions and up-dating as needed and has apparent flexibility for adaptation and change.
*e. The curriculum as developed was an admirable achievement of the Anne Arundel County Public Schools for the decade of the seventies.

2. Unified Science approach weaknesses: C

*a. There is too heavy emphasis on subject matter content and scientific "facts" that are frequently open for change and reinterpretation.
*b. There is too much emphasis on verbal learning which when not meaningful leads to traditional recitation mode of American education.

Source of Data

*c. There is too little emphasis on the discipline of reasoning inherent in the sciences and too little emphasis on how scientific knowledge is produced.
*d. There is too little emphasis on possible careers in science and in science related fields.

B. DOES THE STRUCTURE AND ORGANIZATION OF THE SCIENCE CURRICULUM ALLOW STUDENTS TO ORGANIZE THEIR KNOWLEDGE BASED ON PREVIOUS KNOWLEDGE AND EXPERIENCES?

**Results:**

1. Strengths of the structure and organization of the curriculum: C

*a. It provides consistency of science topic coverage across the county system.
*b. The attempt to develop a spiral approach is commendable and encourages recognition of the continuity of science.

2. Weaknesses of the structure and organization of the system: C

* There is concern that after students have completed all the 21 proficiency levels they may still not be aware of the unifying themes.

3. Articulation within PLO's and across grade levels: PDT-74 to 76

| To what degree does Unified Science: | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| Contribute to the total school program | | | | |
| great/adequate degree | 51.8[a] | 62.0 | 32.6 | 17.9 |
| little/not at all | 4.0 | 10.0 | 20.9 | 29.9 |
| Provide for articulation among PLO's | | | | |
| great/adequate degree | 45.0 | 34.0 | 4.7 | 7.1 |
| little/not at all | 10.3 | 28.0 | 60.5 | 52.8 |
| Provide for articulation among elementary, middle/junior, and senior high levels | | | | |
| great/adequate degree | 41.5 | 27.1 | 19.0 | 7.8 |
| little degree/not at all | 9.9 | 35.5 | 35.7 | 48.4 |

These results suggest that:

a. Over 50 percent of the elementary/middle school teachers report that unified science contributes to the total school program to an adequate or great degree. Less than one-third of junior or senior high school staff members report this same degree contribution.
b. Over 50 percent of junior and senior high staff report that the unified science program provides for articulation among the Proficiency Level Objectives (PLO's) to little degree or not at all. One-third or more of the elementary and middle school teachers report that unified science provides for articulation among PLO's to a great/adequate degree.
c. Elementary teachers were much more likely to respond that unified science provides for articulation among elementary, middle, junior, and senior high schools than teachers at higher levels.
d. Comments given on the survey by staff members who responded little or not at all to these items include: Unified science is not coordinated enough within the school; teachers have no background for advanced subjects; some PLO's are too repetitive; there are too many gaps in unified science; and unified science is poorly planned.

---

[a]All data is reported by the percentage of elementary, middle, junior high, and senior high school staff members who chose each survey response.

Source of Data

C. ARE THE TOPICS, SKILLS, CONCEPTS, AND PROCESSES IN THE SCIENCE CURRICULUM CONSISTENT WITH CURRENT THEORIES OF LEARNING AND INSTRUCTION?

**Results:**

1. Weakness of the program in this area: C

*a. The curriculum as now written does not live up to its stated goals of teaching science as an investigative process.
*b. There is a lack of student involvement in the "processes of science" using the natural phenomena and science oriented investigative equipment.
*c. Much of the material does not reflect our present understanding of the state of the art and does not include recent breakthroughs.

D. DO THE SKILLS, TOPICS, CONCEPTS, AND PROCESSES IN THE SCIENCE CURRICULUM MATCH THE DEVELOPMENTAL CHARACTERISTICS OF LEARNERS?

**Results:**

1. Weakness of the program in this area: C

* There may not be enough attention given to the developmental level of the learners.

E. ARE THE DEMANDS MADE UPON THE TEACHERS TO IMPLEMENT UNIFIED SCIENCE REALISTIC?

**Results:**

1. Strengths of the program in this area: C

* The involvement of the local personnel in the development and growth of the curriculum is highly commendable and helps tailor its nature to the area locale as well as aiding in its later implementation.
* It provides for all formal science instruction for all the county's students at all levels.

2. Weaknesses of the program in this area: C

*a. There is a tremendous responsibility of the teachers to not only be highly trained in all areas of science but also be highly competent and creative in all phases of science instruction.
*b. The teachers' guides lack specificity in leading the reader to teaching the unifying themes, which are open to too much interpretation.
*c. There are an overwhelming number of objectives so that a single teacher might encounter over one thousand of them.
*d. That the hoped for individualization of instruction relies on the teacher and is not properly reflected in the curriculum materials.

3. Goals realistic for teachers: PDT-73

| Does Unified Science set realistic goals and objectives for teachers? | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| great/adequate degree | 52.1 | 52.0 | 25.6 | 16.7 |
| little degree/not at all | 7.4 | 24.0 | 34.9 | 30.9 |

a. Elementary and middle school teachers view the unified science objectives as more realistic for teachers than do junior or senior high school teachers.
b. The primary reason given by teachers who responded that the goals were not realistic was that there was too much material to cover.

F. IN THE UNIFIED SCIENCE CURRICULUM, ARE THE SUGGESTED ACTIVITIES FOR EACH PROFICIENCY LEVEL OBJECTIVE APPROPRIATE TO REACH THE OBJECTIVE?

1. Weaknesses of the program in this area: C

*a. Many of the objectives as presently written are not stated in a form as to be measureable.

Source of Data

*b. There is an overall predominance of the objective described in the taxonomy of objectives in the semester course taxonomies.
*c. The basis of the pre-tests is not clear and post-test interpretations leave too much for interpretation by teacher.
*d. There is too much attention given to the activities and the objectives and too little attention given to the pre-tests and post-tests.
*e. Many of the stated activities are not true science activities and leave little opportunity for students to use the processes of science.

2. Importance of completing all 21 proficiency levels: PDT-81

How important is it for a student to complete all 21 proficiency levels to meet the objectives of Unified Science?

| | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| very/somewhat important | 81.8 | 68.1 | 46.3 | 36.2 |
| slightly/not important | 17.6 | 31.9 | 53.7 | 63.7 |

Most elementary/middle school teachers report that it is very/somewhat important that students complete all 21 proficiency levels to meet the objectives of unified science; most junior and senior high teachers believe that this is slightly/or not important. The reasons given by those teachers placing little importance on completing all 21 proficiency level objectives were:

It is impossible to complete them; it depends on the level of the PLO; it cannot be important if not all the material is covered (priority-secondary PLO's); emphasis should be placed on skill development; and 21 PLO's are not available.

G. ARE THE MATERIALS AND EQUIPMENT SUGGESTED FOR EACH UNIFIED SCIENCE ACTIVITY APPROPRIATE TO REACH THE OBJECTIVE?

**Results:**

1. Weaknesses of materials and equipment: C

*a. There is a lack of congruence between the program strategies and the curriculum materials provided.

H. DO THE OBJECTIVES AND RELATED ACTIVITIES OF THE UNIFIED SCIENCE AND THE ELECTIVE COURSES MEET THE DIVERSE NEEDS OF STUDENTS?

**Results:**

1. Strengths in meeting diverse needs: MS

a. There is a wide variety of offerings geared to student's ability.
b. The curriculum meets the needs of the majority of students.
c. Unified science 9 and 10 are an effort to provide scientific literacy to less able and less motivated students.

2. Weakness of program diversity:

a. Independent study needs greater attention and development. MS
b. Scheduling unified science 9 and 10 needs to remain flexible with biology to emphasize higher level learning outcomes.
*c. The hoped for individualization of instruction relies heavily on the teacher and is not properly reflected in the curriculum materials. C

Source of Data

3. Meeting the individual/common needs of children — PDT 71,72 77 to 80

| To what degree does Unified Science: | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| Provide for the educational needs of children K-10 | | | | |
| adequate/great degree | 59.6 | 50.0 | 30.3 | 19.7 |
| little/not at all | 4.6 | 8.0 | 30.2 | 40.8 |
| Set realistic goals/objectives for students | | | | |
| adequate/great degree | 53.0 | 42.0 | 23.3 | 23.3 |
| little degree/not at all | 8.5 | 26.0 | 37.2 | 57.4 |
| Provide for individual differences | | | | |
| great/adequate degree | 42.3 | 40.0 | 18.7 | 17.6 |
| little degree/not at all | 11.7 | 24.0 | 32.6 | 44.1 |
| Provide for student's common needs | | | | |
| great/adequate degree | 46.5 | 46.9 | 26.2 | 10.3 |
| little degree/not at all | 5.7 | 12.2 | 35.8 | 29.4 |
| Provide for student's individual needs | | | | |
| great/adequate degree | 39.6 | 28.0 | 21.4 | 7.5 |
| little degree/not at all | 11.4 | 22.0 | 40.5 | 37.3 |
| Provide for student's continuous program | | | | |
| great/adequate degree | 53.7 | 54.2 | 30.9 | 15.1 |
| little degree/not at all | 3.8 | 12.5 | 26.2 | 33.4 |

a. Taken as a whole the above six items shed little light on the science program's ability to meet the common/individual needs of students.
b. Elementary and middle school teachers responded that the program met the needs of students while junior and senior high school teachers were more likely to respond that the program did not adequately meet student needs.
c. All teachers indicated that the science program more adequately provided for the educational needs of children K to 10, set realistic goals and objectives for students, and provided for students' continuous progress, than for the individual differences, and individual/common needs of students.
d. Specific comments made by teachers about the unified science program's failure to meet the common/individual needs of the students include: a lot of materials are beyond the students' experiences and understandings; the spiral curriculum does not sufficiently develop coordinated scientific concepts; there is too much to cover to be realistic; unified science is not for all ability levels; the program is somewhat rigid to provide for individual differences; the concepts are difficult for slower students; the program doesn't consider the needs of lower ability students; the program needs more unity; and unified science cannot be continuous if material (PLO's) can be left off.

I. ARE THE MATERIALS OF INSTRUCTION AND EQUIPMENT NECESSARY TO SUPPORT THE SCIENCE PROGRAM AVAILABLE?

**Results:**

1. Available textbooks for unified science: — PDT-55 & 56

| How many texts are required to teach Unified Science? | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| None | 16.6 | 0.0 | 0.0 | 4.6 |
| One | 9.8 | 2.0 | 11.6 | 16.9 |
| Two | 17.4 | 8.2 | 20.9 | 9.2 |
| Three | 12.2 | 8.2 | 20.9 | 6.2 |
| More than three | 43.8 | 81.6 | 44.2 | 63.1 |
| How many of the PLO's you teach are covered by these texts? | | | | |
| All | 6.4 | 30.6 | 9.3 | 7.9 |
| Most | 37.5 | 46.9 | 67.4 | 41.3 |
| Half | 28.2 | 14.3 | 11.6 | 23.8 |
| Few | 22.7 | 8.2 | 11.6 | 23.8 |
| None | 5.2 | 0.0 | 0.0 | 3.2 |

Source of Data

These results suggest that:

a. Over 50 percent of all teachers report that three or more textbooks are required to teach unified science.
b. While three-fourths of the middle and junior high school teachers report that most or all of the PLO's are covered by these texts, this level of coverage is reported by 44 and 49 percent of the elementary and senior high school teachers, respectively.

2. Availability of textbooks to match reading skills: PDT-57 to 60

| To what degree are science textbooks available for students with: | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| well developed reading skills | | | | |
| usually/always | 72.7 | 91.9 | 93.1 | 65.2 |
| seldom/never | 14.5 | 0.0 | 2.3 | 18.8 |
| average reading skills | | | | |
| usually/always | 60.6 | 85.7 | 88.3 | 62.7 |
| seldom/never | 13.6 | 2.0 | 0.0 | 16.4 |
| poorly developed reading skills | | | | |
| usually/always | 17.6 | 35.5 | 34.9 | 26.8 |
| seldom/never | 61.3 | 37.9 | 37.2 | 39.2 |

These results suggest that:

a. Textbooks for unified science are most often available for students with well developed reading skills and least available for students with poorly developed reading skills.
b. Middle and junior high school teachers are more likely to locate science textbooks for all levels of reader than are elementary and senior high school teachers.

3. Availability of Unified Science Taxonomies of Objectives and Teachers' Guides to teachers: PDT-60 & 61

| Do you have copies of: | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| Taxonomies of Objectives | | | | |
| most/all | 94.6 | 87.7 | 81.4 | 90.9 |
| few/none | 4.1 | 2.0 | 14.0 | 4.5 |
| Teacher's Guide | | | | |
| most/all | 96.3 | 57.1 | 39.1 | 50.0 |
| few/none | 1.9 | 18.3 | 39.0 | 39.4 |

The staff's responses to these items indicate:

a. Almost all teachers have access to the unified science Taxonomies of Objectives.
b. More than 90 percent of elementary teachers report having copies of unified science Teachers' Guides.
c. About one-half of the middle and senior high school teachers report having copies of Teachers' Guides; about 39 percent of junior high school teachers report having them.

4. Laboratory materials and equipment: PDT-66 to 67

| Required unified science laboratory materials are: | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| available in sufficient quantity | 41.9 | 61.2 | 58.5 | 24.6 |
| available in insufficient quantity | 48.8 | 34.7 | 36.6 | 70.8 |
| not available | 8.5 | 2.0 | 4.9 | 4.6 |
| Required unified science equipment is: | | | | |
| available in sufficient quantity | 44.5 | 60.4 | 52.4 | 27.7 |
| available in insufficient quantity | 49.1 | 37.5 | 42.9 | 64.6 |
| not available | 5.9 | 0 | 4.8 | 6.2 |

Source of Data

These results suggest that:

More than 70 percent of senior high school teachers report that laboratory materials and equipment are not available or are available in insufficient quantity. This level of material and equipment availability is reported by more than half the elementary teachers, more than 40 percent of the junior high school teachers, and more than one-third of the middle school teachers.

5. Condition of laboratory equipment — PDT-68

| | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| all/most in working order | 69.1 | 87.2 | 65.2 | 63.7 |
| half in working order | 17.7 | 6.4 | 25.6 | 23.2 |
| all/most in need of repair or replacement | 13.3 | 6.4 | 9.3 | 11.8 |

This data indicates that about three-fourths of the staff report most or all of the laboratory equipment to be in working order.

J. DO THE SCIENCE FACILITIES SUPPORT THE SCIENCE CURRICULUM?

**Results:**

1. Facilities safety and provision for science implementation: — PDT-69 to 70

| Do the facilities provide for the full implementation of unified science? | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| adequate/great degree | 50.2 | 61.7 | 39.6 | 41.8 |
| little/not at all | 8.1 | 14.9 | 18.3 | 22.4 |
| Are facilties designed to ensure the safety of persons and property? | | | | |
| adequate/great degree | 70.4 | 70.8 | 63.4 | 58.4 |
| little/not at all | 4.1 | 10.4 | 22.0 | 9.7 |

These results indicate that:

a. Science facilities in elementary and middle schools provide for the full implementation of unified science to a greater degree than do those in junior and senior high schools. Teachers in elementary and middle schools also perceive that the facilities ensure the safety of persons and property more than those in junior and senior high schools.
b. Where facilities do not provide for unified science implementation or ensure safety, teachers give these reasons: facilities are too limited (classrooms are too small, no gas or water, etc.), and there are too many students in the laboratory classroom.

2. Other information about facilities: — MS

An examination of Middle States evaluation of high school science facilities over the last five years reveals the following:

a. Commendations: facilities are outstanding (new school); open space facilities promote team planning and teaching; laboratories (for advanced chemistry) stress the use of equipment and quantitative and qualitative analysis; other science facilities are available to students in the area to supplement and support school programs (e.g., Maryland Academy of Science, Chesapeake Bay Foundation, Arlington Echo, Maryland Science Center, Smithsonian Institution, and Goddard Space Flight Center).
b. Recommendations: All recommendations specified the installation of equipment/facilities where it was needed (e.g., greenhouse, storage facilities for live animals, ventilation hoods, storage space, securing chemistry areas, chalk and bulletin boards, blackout curtains, bookshelves), renovations of facilities, modifications to open space areas to support independent work, and routine maintenance of facilities.

II. STUDENT PERFORMANCE, PREPARATION, ATTITUDES AND LATER SUCCESS:

A. WHAT ARE THE CHARACTERISTICS OF STUDENTS IN THE UNIFIED SCIENCE AND ELECTIVE COURSE AT THE SECONDARY LEVEL?

Source of Data

**Results:**

1. Courses students enrolled in: CR

| Courses | Percentage of Students in Programs Who Enrolled in Each Course | | | | Percentage of Students in Sample Who Enrolled in Each Course |
|---|---|---|---|---|---|
| | Academic | General | Commercial | Vocational | |
| Unified Science 9 | 75.1 | 85.1 | 87.0 | 76.4 | 80.7 |
| Unified Science 10 | 41.6 | 63.4 | 75.1 | 38.2 | 56.0 |
| General Biology | 35.1 | 36.6 | 18.9 | 18.2 | 29.6 |
| BSCS Biology - Green | 3.5 | 0.5 | 1.1 | 0.0 | 1.8 |
| BSCS Biology - Yellow | 31.1 | 8.4 | 8.1 | 5.5 | 16.6 |
| BSCS Biology - Blue | 1.6 | 0.0 | 0.0 | 0.0 | 0.5 |
| Academic Botany | 3.9 | 2.5 | 1.1 | 0.0 | 2.6 |
| General Botany | 2.7 | 5.0 | 2.2 | 0.0 | 3.0 |
| Human Physiology | 4.7 | 2.0 | 2.2 | 0.0 | 2.7 |
| Zoology | 16.3 | 4.0 | 2.2 | 1.8 | 8.0 |
| Advanced Biology | 1.9 | 1.0 | 0.0 | 0.0 | 0.9 |
| General Chemistry | 73.5 | 10.4 | 4.3 | 10.9 | 32.0 |
| Practical Chemistry | 6.6 | 7.9 | 1.1 | 0.0 | 5.2 |
| Organic Chemistry | 0.4 | 0.0 | 0.0 | 0.0 | 0.1 |
| Advanced Chemistry | 7.8 | 0.0 | 0.0 | 0.0 | 2.8 |
| General Physics | 29.2 | 4.0 | 0.0 | 0.0 | 11.4 |
| PSSC Physics | 1.9 | 1.0 | 0.5 | 0.0 | 1.2 |
| Advanced Physics | 1.2 | 0.0 | 0.0 | 0.0 | 0.4 |
| Physical Science | 2.3 | 7.9 | 1.6 | 1.8 | 4.2 |
| Applied Science | 0.4 | 4.0 | 0.0 | 0.0 | 1.2 |
| Environmental Science | 2.3 | 5.9 | 1.6 | 1.8 | 3.4 |
| Ecology | 0.8 | 2.0 | 0.5 | 60.0 | 5.7 |
| Geology | 0.0 | 0.0 | 0.0 | 0.0[b] | 0.1 |
| Oceanography | 10.1 | 8.9 | 3.2 | 1.8 | 7.3 |
| Astronomy | 4.7 | 4.0 | 2.2 | 1.8 | 3.7 |
| Marine Biology | 3.5 | 4.5 | 2.2 | 0.0 | 3.4 |
| Genetics | 0.0 | 0.0 | 0.0 | 0.0[b] | 0.1 |
| Chesapeake Bay Studies | 0.4 | 2.0 | 0.5 | 0.0 | 0.8 |
| Animal Kingdom | 1.9 | 6.9 | 1.6 | 3.6 | 3.8 |
| Microbiology | 3.5 | 2.5 | 1.1 | 1.8 | 2.4 |
| Human Biology | 1.9 | 1.5 | 0.0 | 0.0 | 1.4 |

These results indicate that:

a. The science courses that most students take, in order, are:

| | |
|---|---|
| Unified Science 9 | 80.7% |
| Unified Science 10 | 56.0% |
| A Biology Course (General or BSCS) | 48.5% |
| General Chemistry | 32.0% |
| Physics (General or PSSC) | 12.6% |
| All Remaining Electives | Less than 10% |

NOTE: An examination of 14,805 students who have scheduled science for the 1981-82 school year verifies that these five courses are the most regularly requested although the percentages vary. In the 1981-82 school year, 27 percent of students in grades 9 through 12 are enrolled in a biology course, 22 percent are enrolled in unified science 9, 11 percent in chemistry, ten percent in unified science 10, and six percent in physics. CS

b. Academic students are the students who elect most science courses, with the following exceptions: CR
   1) More general students than academic, commercial or vocational enroll in unified science 10, general botany, physical science, environmental science, animal kingdom, and Chesapeake Bay studies.

[b]The programs of students enrolled in this course were not evident in their cumulative records. It was not possible, therefore, to report the percentage of students enrolling in the course by program.

Source of Data

2) More vocational students take ecology than students in other programs.

2. Science credits students earn: CR

Currently students are required to earn two Carnegie units in science for graduation. However, many students choose to earn more than the required credits.

| Credits | Percentage of Sample Earning |
|---|---|
| 2.0 | 45 |
| 2.5 | 9 |
| 3.0 | 16 |
| 3.5 | 5 |
| 4.0 | 14 |
| 4.5 | 2 |
| 5.0 | 2 |
| More than 5.0 | Less than 1 |

The average number of science credits earned by students in the various programs are:

| Program | Average Number of Science Credit Earned |
|---|---|
| Academic | 3.18 |
| General | 2.29 |
| Commercial | 2.04 |
| Vocational | 2.05[c] |

B. WHAT IS THE SEQUENCE OF COURSES STUDENTS ELECT IN GRADES 9-12? DOES THE SEQUENCE MATCH RECOMMENDED COURSE SEQUENCES?

**Results:**

1. Courses students elect:

The following table lists the science courses and the level for which each course was designed. The right portion of the table lists the average ability (Standard Age Score), reading comprehension, and math scores (national percentiles) of students enrolled in each course. This analysis was conducted by matching students enrolled in science courses in the 1980-81 school year with their ninth grade test results. (All test scores are from ninth grade accountability testing).

Average ability and achievement test scores for Unified Science 9, General Biology, and BSCS Biology have been deleted from this table. Unified Science 9 is completed in grade 9; General and BSCS Biology are elected by advanced students prior to grade 10. Since the ability and achievement test scores for students who completed Unified Science 9 and General or BSCS Biology prior to grade 10 are not included in this data, the use of test scores for these courses as representing of all students in Unified Science 9, or General and BSCS Biology would be misleading.

[c]Vocational students earn science credits in regular science courses or as a related credit upon completing their first year in a trade program. Of the vocational students represented in the sample above 41.1 percent earned all their science credits in regular science courses; 51.8 percent earned one related science credit; 7.2 percent earned more than one related credit.

Source of Data TSD

| Course | Designed for 1 = Academic 2 = Average 3 = Below Level | Test Scores: Ability (Standard Age Score) | Reading Comprehension (Mean NP) | Mathematics (Mean NP) |
|---|---|---|---|---|
| Unified Science 10 | 1,2,3 | 96.5 | 22.7 | 21.6 |
| Advanced Biology | 1 | 117.2 | 62.7 | 56.0 |
| General Botany | 2,3 | 106.0 | 39.5 | 34.7 |
| Academic Botany | 1,2 | 113.3 | 59.3 | 47.6 |
| Human Physiology | 1,2 | 116.4 | 59.1 | 57.4 |
| Zoology | 1 | 114.7 | 59.4 | 54.6 |
| General Chemistry | 1,2 | 117.8 | 60.9 | 62.3 |
| Practical Chemistry | 2 | 116.4 | 57.7 | 57.7 |
| Organic Chemistry | 1 | 125.5 | 75.3 | 81.3 |
| Advanced Chemistry | 1 | 125.5 | 73.8 | 73.7 |
| General Physics | 1,2 | 122.1 | 69.1 | 70.4 |
| PSSC Physics | 1 | 129.0 | 83.0 | 90.8 |
| Advanced Physics | 1 | 140.0 | 83.8 | 90.5 |
| Physics Seminar | 1 | 140.0 | 83.8 | 90.5 |
| Physical Science | 2 | 102.9 | 32.6 | 33.4 |
| Environmental Science | 2,3 | 108.5 | 42.7 | 43.5 |
| Ecology | 2 | 102.2 | 38.3 | 34.7 |
| Geology | 2 | 108.2 | 49.0 | 44.8 |
| Oceanography | 2 | 107.4 | 44.8 | 43.5 |
| Astronomy | 1 | 111.7 | 48.2 | 47.8 |
| Marine Biology | 1 | 105.9 | 45.4 | 36.3 |
| Genetics | 1 | 118.3 | 64.7 | 57.8 |
| Chesapeake Bay Studies | 1,2 | 99.2 | 31.9 | 26.9 |
| Animal Kingdom | 3 | 96.8 | 23.0 | 21.5 |
| Microbiology | 1 | 116.1 | 56.6 | 58.0 |
| Human Biology | 3 | 103.4 | 36.2 | 33.3 |

2. Course level and ability/achievement:

TSD TYP

| Level Courses Designed for | Average Ability | Average Reading (National Percentile) | Average Mathematics |
|---|---|---|---|
| 1 | 116.9 | 61.0 | 58.1 |
| 1,2 | 117.2 | 60.6 | 60.0 |
| 2 | 110.0 | 44.7 | 48.6 |
| 2,3 | 107.4 | 41.4 | 40.0 |
| 3 | 99.3 | 24.2 | 21.6 |

For the most part it appears that students are enrolling in courses which match their abilities and achievement levels (as measured by Cognitive Abilities Test and ITBS)[d]. Ability and achievement scores are higher for academic science courses than for courses designed for below average students. There are some exceptions to this however.

a. The ability scores of students in marine biology and Chesapeake Bay studies are lower than the mean ability scores of students in other courses designed for average and academic students. Either fewer high ability students elect these courses or they are taught more as average level than academic level courses.
b. Even in courses where the mean ability/achievement corresponds to the level for which the course has been designed, there is variability in students' ability and achievement. Note the table below.

| Courses | Level Designed For | Percentage of Students in the Ability/Achievement Level: Ability Level Below Average | Ability Level Average | Ability Level Above Average | Reading Level Below Average | Reading Level Average | Reading Level Above Average |
|---|---|---|---|---|---|---|---|
| Astronomy | 1 | 8% | 40% | 51% | 17% | 68% | 15% |
| Animal Kingdom | 3 | 21% | 58% | 16% | 58% | 41% | 1% |

There are high and low ability, above and below average readers in both of these courses. Although each course tends to serve the population for which it was designed, there will be some students who are mismatched by test scores with the course for whatever reason: guidance, interest, course availability, etc.

[d] ITBS = Iowa Tests of Basic Skills

Source of Data

c. Students in unified science 10 have the same ability/achievement characteristics as students in below average science courses. Unified science 10 is not taken by all students, it is taught as a level 3 science course in some senior high schools and is not offered in others.

3. The sequence in which students enroll in science courses: CR

To answer this question each course was classified into one of six categories: unified science 9, unified science 10, biology (general and BSCS), general chemistry, physics (general and PSSC), and electives (all other courses). Although the number of credits students earn was known, the sequence of these courses was not available in any form.

Fifty-two patterns and combinations were revealed with between 1 and 161 students represented by each pattern. The ten most frequent science course patterns were:

| Course Pattern | Unified 9 | Unified 10 | Biology | Chemistry | Physics | Elective | Percentage of Students Electing Pattern |
|---|---|---|---|---|---|---|---|
| 1 | X | X | | | | | 21.8 |
| 2 | X | X | | | | X | 10.4 |
| 3 | X | | X | | | | 7.3 |
| 4 | X | | X | X | | | 4.5 |
| 5 | X | | | | | X | 4.3 |
| 6 | X | X | X | | | | 3.5 |
| 7 | X | | X | X | | X | 3.5 |
| 8 | X | | X | | | X | 3.4 |
| 9 | X | | X | X | X | | 3.4 |
| 10 | X | X | | X | | X | 2.8 |

The above ten patterns account for 64.9 percent of the total sample. The remaining 38.6 percent of the sample represent forty two other patterns of these course types.

C. HOW DO GRADUATES OF ANNE ARUNDEL COUNTY PUBLIC SCHOOLS FEEL ABOUT THEIR SCIENCE PROGRAM IN RETROSPECT? WHAT ARE THEIR ATTITUDES TOWARD SCIENCE?

This section of the report is a compilation of the responses of former students. Responses were analyzed by sex and by career (science or non-science). Results are reported by these two dichotomies only if the groups within the dichotomy differed significantly in their responses. All data is reported in percentages of students responding.

**Results:**

1. Graduates satisfaction with their science education: FS-4 & 5

| | Satisfied or Very Satisfied | | Dissatisfied or Very Dissatisfied | |
|---|---|---|---|---|
| Satisfaction with: | | | | |
| Science Education | 76.9(SC)[e] | 54.1(NSC)[e] | 7.7(SC) | 5.5(NSC) |
| Number and Variety of Courses | 61.5 | | 19.0 | |

Additional Courses: FS-6

| Taken Science Education | SC | NSC |
|---|---|---|
| Yes | 76 | 40 |
| No | 24 | 60 |

Graduates employed in science careers are more satisfied with their science education than those in non-science careers, and also wish they had taken more courses. The courses students report that they would like to have studied are (in order of response): FS-6

| Course | Number Selecting |
|---|---|
| Physics | 10 |
| Zoology | 9 |
| Chemistry | 9 |
| Biology | 8 |
| Anatomy | 7 |

[e] SC = Science Career
NSC = Non-Science Career

Source of Data

The remaining courses (such as advanced biology, marine biology, advanced physics) were listed by three or fewer respondents. While most courses listed are electives currently offered, some students did suggest new courses: embryology (2); anthropology (1), horticulture (1), forensics (1), space and underwater technology (1).

Forty-four percent of the sample report that they have taken additional science courses since high school. (Of those graduates in science-oriented careers, 57.7 percent report having taken additional courses.) FS-39 & 40

Of those graduates who have enrolled in science courses since high school, 70.7 percent report that they were prepared or very well prepared for these courses.

2. Graduates' perceptions about the way science is taught:

To address this issue two sets of questions were asked. The first dealt with attitudes toward the things studied in science, the second set dealt with the students' role in shaping their own education.

How often were the things you studied in science class: FS-7 to 13

| | Often/ Always | Seldom/ Never |
|---|---|---|
| Boring | 25.0(M)[f] 17.9(F)[f] | 35.7(M) 18.9(F) |
| Interesting | 49.7 | 8.5 |
| Too difficult | 5.9 | 54.3 |
| Too easy | 17.7 | 41.2 |
| Things already learned in school | 19.1 | 26.3 |
| Things already learned outside of school | 11.2 | 44.1 |
| Facts you had to memorize | 47.3 | 17.7 |

These responses suggest that:

a. While females took a moderate position whether or not science classes were boring, males took a more extreme postion. More males than females said it was often/always boring and seldom/never boring.
b. More students found science to be always/often interesting than seldom/never interesting. More students found science to rarely/seldom be too difficult or too easy than always/often too difficult or too easy.
c. More students reported that science classes seldom/never cover things already learned outside of school than reported always/often.
d. More students reported that science classes often/always focused on facts that had to be memorized than reported seldom/never.

How often have you done each of the following: FS-14 to 18

| | Often/ Always | Seldom/ Never |
|---|---|---|
| Chosen a topic yourself | 18.9 | 47.7 |
| Chosen the way you wanted to learn | 6.6 | 71.3 |
| Selected the order in which you studied science | 9.8 | 80.4 |
| Gotten to work at your own speed | 21.6 | 52.3 |
| Gotten to decide when to hand in an assignment or take a test | 3.3 | 85.6 |

Most students report little involvement in deciding topics, how they are taught, the order in which topics are taught, the speed of learning or when to hand in assignments or take tests.

3. Graduates perceptions about science education in general: FS-19 to 24

In all but one of these items there was a difference in the way males/females or science/non-science employed graduates responded to these items.

---

[f] M = Males F = Females

| | Agree or Strongly Agree | | Disagree or Strongly Disagree | | Source of Data |
|---|---|---|---|---|---|
| Science classes are useful | 88.8(M) 79.2(F) | 100(S) 70.2(NS) | 7.4(M) 5.2(F) | 0(S) 10.9(NS) | |
| Science classes have nothing to do with the real world | 3.8(S) | 9.3(NS) | 96.1(S) | 76.0(NS) | |
| Science should be required in school | 96.1(S) | 76.0(NS) | 0(S) | 16.0(NS) | |
| Science graduation requirements should be increased beyond 2 years | 50.9(M) | 35.4(F) | 18.1(M) | 42.7(F) | |
| What is learned in science is useful in everyday life | 69.3(S) | 33.8(NS) | 19.2(S) | 40.6(NS) | |
| Much of what is learned will be useful in the future | 65.1 | | 17.1 | | |

General trends evident in this data are:

a. People who use science daily see science classes as more useful and agree more that science should be required in high school than those in non-science careers.
b. Males more strongly agreed that science classes were useful than females. In addition they more strongly agreed that science graduation credits should be increased beyond two years than did females.
c. About two-thirds of the respondents think what they learned will be useful at some future time.

4. Science-related activities outside school:

Two sets of questions were asked of students. The first set asked students to report how often they engaged in science-related activities. The second set related to specific science processes engaged in as part of science instruction.

| | Often/ Always | | Seldom/ Never | | FS- 25 to 32 |
|---|---|---|---|---|---|
| Read science articles | 73.1(S)<br>58.9(M) | 30.6(NS)<br>32.3(F) | 7.7(S)<br>10.7(M) | 37.4(NS)<br>38.5(F) | |
| Watch science TV shows | 60.0(S) | 31.1(NS) | 16.0(S) | 33.8(NS) | |
| Gone to talks on science | 32.0(S) | 4.1(NS) | 56.0(S) | 86.5(NS) | |
| Read about science or scientists | 30.7(S) | 7.0(NS) | 46.2(S) | 65.3(NS) | |
| Talked about science with friends | 53.9(S)<br>40.0(M) | 19.2(NS)<br>20.2(F) | 15.4(S)<br>21.8(M) | 50.7(NS)<br>50.0(F) | |
| Done science projects | 24.0(S) | 8.1(NS) | 56.0(S) | 82.4(NS) | |
| Science-related hobbies | 45.9(S)<br>23.7(M) | 8.2(NS)<br>15.0(F) | 33.4(S)<br>45.4(M) | 71.2(NS)<br>68.8(F) | |
| Visited a science musuem, exhibit center | 30.8(S)<br>14.9(M) | 16.7(NS)<br>22.3(F) | 46.1(S)<br>46.3(M) | 48.6(NS)<br>43.7(F) | |

General trends evident in this data are:

a. Graduates with science-oriented careers perform each of the above activities more often than those with non-science careers. Almost one-third of the graduates with a non-science career report watching science shows on TV or reading science articles in magazines and newspapers.
b. More males than females read science articles, talk about science-related hobbies. However, more females than males report visiting a science museum, display, exhibit or center.

Source of Data

In solving problems since you left high school, how often have you: FS-33 to 38

| | Many Times | | Not Very Often | | Never | |
|---|---|---|---|---|---|---|
| Done an experiment | 34.6(S) | 11.1(NS) | 42.3(S) | 36.1(NS) | 23.1(S) | 52.8(NS) |
| | 25.9(M) | 14.7(F) | 51.8(M) | 35.8(F) | 22.2(M) | 49.5(F) |
| Taken measurements | 80.8(S) | 48.6(NS) | 19.2(S) | 43.3(NS) | 0(S) | 8.1(NS) |
| | 78.2(M) | 47.9(F) | 20.0(M) | 43.7(F) | 1.8(M) | 8.3(F) |
| Made careful observations | 65.4(S) | 37.8(NS) | 34.6(S) | 50.0(NS) | 0(S) | 12.2(NS) |
| | 56.4(M) | 43.8(F) | 43.7(M) | 43.7(F) | 0(M) | 12.5(F) |
| Tried to find out more about a problem | 67.3(M) | 50.0(F) | 29.1(M) | 45.8(F) | 3.6(M) | 4.2(F) |
| Thought of several ways to solve a problem | 70.9(M) | 56.3(F) | 29.1(M) | 40.6(F) | 0(M) | 3.1(F) |
| Solved a problem by the scientific method | 53.8(S) | 20.3(NS) | 30.8(S) | 52.7(NS) | 15.4(S) | 27.0(NS) |
| | 45.5(M) | 23.2(F) | 43.7(M) | 48.4(F) | 10.9(M) | 28.4(F) |

The trends in this data indicate that:

a. Males perform each of the activities more often than females.
b. Graduates in science-related careers do experiments, take measurements, make careful observations, and solve problems by the scientific method more often than those employed in non-science careers.

5. Students' beliefs about their impact on solving world problems:

As a result of your science education, do you believe that you can help solve the problems of: FS-41-46

| | Definitely or Probably Yes | Not Sure | Definitely or Probably No |
|---|---|---|---|
| Pollution | 46.7 | 25.0 | 27.6 |
| Energy Waste | 59.2 | 15.9 | 23.0 |
| Food Shortages | 46.8 | 26.3 | 25.7 |
| Disease | 37.9 | 24.8 | 36.7 |
| Running out of natural resources | 58.9(M) 34.0(F) | 14.3(M) 29.8(F) | 26.8(M) 36.2(F) |
| Accidents | 50.3 | 28.1 | 20.9 |

Although the majority of students felt they could do something to solve the problems of energy waste and accidents, fewer than half the graduates believe they could have an impact on the other problems. In addition, more males felt they could solve the problems of running out of natural resources than did females.

A second series of world problems was to be addressed from the standpoint of the general application of science.

How much do you think science can help: FS-47 to 53

| | Very Much | Some | None |
|---|---|---|---|
| Prevent worldwide starvation | 53.6 | 40.5 | 5.9 |
| Save us from an energy shortage | 68.7 | 30.7 | 1.6 |
| Find cures for diseases | 72.5 | 21.6 | 5.2 |
| Control weather | 22.2 | 46.4 | 30.1 |
| Prevent wars | 11.8 | 50.0 | 36.8 |
| Save our natural resources | 57.9 | 37.5 | 3.9 |
| Improve worldwide communication | 76.4(M) 54.2(F) | 20.0(M) 39.6(F) | 3.6(M) 6.3(F) |

With the exception of preventing wars and controlling weather, more than 90 percent of the sample believes that science can have an effect on most world problems. More males than females believe science can improve worldwide communication.

Source of Data

The above two sets of world problems, taken together, reveal that:

a. although graduates believe science can assist in solving or preventing world problems, most graduates do not believe they personally can solve many of the problems.
b. whether or not a graduate had a science-oriented career had no impact on his/her perception of science's role in solving world problems.

D. WHAT IS THE STUDENT'S CURRENT KNOWLEDGE OF SCIENCE PROCESS AND CONTENT?

**Results:**

1. Sequential Tests of Educational Progress: AT

As described in the Procedures section of this report, a sample of students was administered the Sequential Tests of Educational Progress (STEP). Reported below is the national percentile of the mean score for each test administered.

| Test | Grade | Number of Students Tested | Group National Percentile |
|---|---|---|---|
| General Science | 4 | 128 | 82 |
| General Science | 6 | 135 | 82 |
| General Science | | | |
| Biological Science | 9 | 117 | 68 |
| Earth Science | 9 | 117 | 68 |
| Physical Science | 9 | 117 | 76 |
| End of Course | | | |
| Biology | SHS | 114 | 41 |
| Chemistry | SHS | 114 | 43 |
| Physics | SHS | 101 | 76 |

2. Scholastic Aptitude Tests: SAT

A second set of test data available is the mean score of Anne Arundel County students on the Scholastic Aptitude Tests Achievement Tests in Biology, Chemistry, and Physics from 1976 through 1980. (Scores are reported by the College Board only if the test was taken by 25 or more students). For comparison purposes, the mean achievement test scores for the State of Maryland and the Nation are also reported.

| | BIOLOGY | | | CHEMISTRY | | | PHYSICS | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Anne Arundel County | Maryland | Nation | Anne Arundel County | Maryland | Nation | Anne Arundel County | Maryland | Nation |
| 1980 | ----- | 565 | 551 | 552(42)[g] | 589 | 573 | ----- | 589 | 592 |
| 1979 | 583(30)[g] | 553 | 547 | 586(30) | 587 | 575 | 606(28) | 582 | 580 |
| 1978 | 549(28) | 555 | 544 | ----- | 593 | 577 | 616(27) | 600 | 591 |
| 1977 | 548(32) | 562 | 543 | 582(25) | 593 | 574 | 600(31) | 599 | 593 |
| 1976 | 549(41) | 566 | 543 | 565(28) | 585 | 567 | 583(33) | 592 | 592 |

An examination of these tables of achievement test results reveals the following:

a. All students who took the general science tests in grades 4,6,9 had received instruction in Unified Science. The performance of all three groups of students was above the national norm.
b. The general science test administered in grade 9 was comprised of three content area tests: biological, earth, and physical science. Students scored above the national norm in all three areas; the highest content area of performance was physical science.
c. The achievement of the sample of students in biology and chemistry was below the national norm. That is, in biology the average score of the 114 students tested surpassed 41% of the groups of students in the norming sample. Students who took the physics test performed better than 76% of the students nationally.

[g] Number of students taking the test.

d. Achievement test scores for the Scholastic Aptitude Test over the past five years indicate the following:

1) Biology - scores show an increasing trend from 1978 to 1979. Although scores were below the mean for the State of Maryland in three years, in the last year for which a test mean is available, students scored above the Maryland mean. In all years for which a county mean is available, Anne Arundel County students scored above the national average.

2) Chemistry - County scores are incomplete, but show a sharp decline from 1979 to 1980. In all years students in Anne Arundel County scored below the Maryland average. They scored above the national average in two years and below in two years.

3) Physics - County means show an increase until 1979 when the mean dropped ten points. In the last three years for which scores are available in physics, students in Anne Arundel County scored above the Maryland and national mean.

4) The numbers of students electing to take SAT achievement tests in biology, and physics is declining. For 1980 fewer than 25 students took the biology and physics tests. In chemistry the number taking the tests appears to be increasing.

E. ADDITIONAL COMMENTS MADE BY GRADUATES ABOUT THE SCIENCE PROGRAM.

A final item asked former students to comment on anything else they would like to tell about their experiences in the science program. One hundred-twenty nine comments were made. The comments are classified by positive comments, negative comments, suggested changes and other comments. Under each category comments are listed in descending order of frequency. The numbers in parenthesis represent the number of former students making each type of comment.

1. Positive comments (18):
   - The science program was good, exciting, interesting. (10)
   - Science was helpful and was related to real work. (5)
   - Teaching was good, teachers were interesting, good personalities. (3)

2. Negative comments (18):
   - Teaching, guidance was poor, teachers were non-caring, out of date, not individual enough. (8)
   - The science program was poor, boring or inadequate. (5)
   - The science program does not prepare students for college courses or the practical world. (4)
   - Science was too easy, make it harder. (1)

3. Comments Suggesting Changes (27): (27)
   - Add to the number and variety of courses (environmental problems, computer science, for gifted/talented, slower students) (14)
   - Replace high school unified science with biology and chemistry. (2)
   - Increase course requirements (5)
   - Do not increase science requirements (1)
   - Science in high school should be mandatory (1)
   - More field trips (1)
   - Need more texts and requirements (1)
   - Make the courses harder (1)
   - Change from open space for science classes (1)

4. Other Comments: (3)
   - Science is not one of my most interesting subjects (1)
   - Most negative comments I have about science and high school come from peer pressure. (1)
   - Success in science depends more on student motivation and taking advantage of course opportunities than the science program. (1)

Source of Data

## III. TEACHER PREPARATION, ATTITUDES AND INSTRUCTIONAL STRATEGIES AS THEY RELATE TO THE SCIENCE PROGRAM.

### A. WHAT ARE THE CERTIFICATION AND YEARS OF TEACHING EXPERIENCE WITH UNIFIED SCIENCE?

**Results:**

1. Certification characteristics: PDT-2

| | |
|---|---|
| Advanced Professional Certificate | 75% |
| Professional Certification | 24% |
| Provisional Certification | 1% |

2. Years teaching unified science PDT

| Number of Years | Percent of Respondents | Number of Years | Percent of Respondents |
|---|---|---|---|
| Less than 1 | 6% | 6 | 11% |
| 1 | 7% | 7 | 10% |
| 2 | 8% | 8 | 15% |
| 3 | 7% | 9 | 6% |
| 4 | 9% | 10 | 4% |
| 5 | 7% | Missing or More than 10 years | 11% |

3. Number of college credits earned in science. PDT

Range = 0 to 133 Credits

| Level | Average Science Credits Earned |
|---|---|
| Elementary | 16.5 credits |
| Middle | 48.8 credits |
| Junior | 65.1 credits |
| Senior | 67.9 credits |

### B. WHAT ARE THE STAFF DEVELOPMENT NEEDS OF SCIENCE TEACHERS? WHAT STAFF DEVELOPMENT IS PROVIDED?

**Results:**

1. Inservice participation and interest. PDT-6 to 35

Listed below are the staff development inservice workshops in science provided by Anne Arundel County Schools, the number of teachers reporting participation in them, and the number of teachers indicating an interest in participating. The table is broken down by elementary, middle/junior high school, and senior high school.

| Inservice | Participated | | | Interested in Participating | | |
|---|---|---|---|---|---|---|
| | Elem. | JHS/Middle | SHS | Elem. | JHS/Middle | SHS |
| Unified Science | 38 | 23 | 11 | 20 | 11 | 4 |
| Individualized Science Laboratory | 3 | 2 | 1 | 16 | 15 | 12 |
| Aerospace Education for Teachers | 15 | 10 | 10 | 31 | 11 | 13 |
| Developing Competencies in Teaching Unified Science | 8 | 1 | 2 | 33 | 12 | 5 |
| Science 7-9 | 1 | 4 | 1 | 2 | 14 | 1 |
| Unified Science Workshop for Elementary Teachers | 46 | 4 | 1 | 95 | 6 | 0 |
| Moving Toward Individualized and Self Pacing in Unified Science | 6 | 3 | 2 | 29 | 9 | 6 |
| Developing Instructional Materials for Teachers of Unified Science | 10 | 6 | 4 | 42 | 7 | 6 |
| Developing Instructional Strategies for Open Space Science | 2 | 2 | 0 | 19 | 9 | 3 |
| Curriculum Development and Instructional Strategies for Unified Science | 2 | 0 | 0 | 14 | 9 | 5 |
| Curriculum Development and Instructional Strategies for Earth-Space Science | 0 | 1 | 0 | 8 | 10 | 6 |

Source of Data

| Inservice | Participated Elem. | Participated JHS/Middle | Participated SHS | Interested in Participating Elem. | Interested in Participating JHS/Middle | Interested in Participating SHS |
|---|---|---|---|---|---|---|
| Curriculum Development and Instructional Strategies for Biology Program | 0 | 0 | 0 | 6 | 9 | 11 |
| Marine Science Program | 4 | 3 | 8 | 17 | 13 | 12 |
| Unified Science Approach in Elementary Science Education | 4 | 1 | 0 | 61 | 2 | 0 |
| Unified Science for Elementary and Middle School Teachers | 4 | 3 | 0 | 21 | 12 | 0 |
| Total Teachers By Level | 143 | 63 | 40 | 414 | 149 | 81 |
| Total Teachers | | | 246 | | | 644 |

These results can serve as a needs assessment for staff development by indicating the inservice programs where interest for participation is highest from this principals', department chairpersons' and teachers' survey.

2. Teachers' preparation to teach unified science? PDT-82

Teachers were asked to rate their preparation to teach unified science (percent of teachers)

| Rating | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| Excellent | 24.0 | 39.1 | 18.6 | 14.7 |
| Satisfactory | 71.1 | 43.5 | 55.8 | 58.8 |
| Unsatisfactory | 3.3 | 15.2 | 18.6 | 14.7 |
| Very Poor | 0.6 | 2.2 | 7.0 | 11.8 |

Its clear from these responses that elementary teachers rate their preparation to teach unified science highest. Ratings decrease with grade level; senior high school teachers rate their preparation lowest. Of the teachers who rated their training as unsatisfactory or very poor, twenty-seven indicated that they were not trained to teach the diversity of subject matter characteristic of unified science.

C. TO WHAT DEGREE IS THE UNIFIED SCIENCE CURRICULUM IMPLEMENTED K-12?

**Results:**

1. Implementation of unified science:

To what degree is the unified science program implemented in your classroom? (percentage) PDT-36

| | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| Fully implemented | 35.3 | 49.0 | 28.6 | 23.0 |
| Strongly implemented | 31.8 | 30.6 | 19.0 | 21.6 |
| Average implementation | 30.3 | 16.3 | 28.6 | 32.4 |
| Weakly implemented | 2.4 | 4.1 | 16.7 | 9.5 |
| Not implemented | 0 | 0 | 7.1 | 13.5 |

Which of the following describes unified science as it is taught in your classroom? PDT-37

| | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| I do not teach unified science | 0.8 | 4.4 | 9.8 | 21.9 |
| I am preparing to teach unified science | 0.3 | 0 | 4.9 | 2.7 |
| Most attention is focused on managing and organizing the course. | 13.4 | 13.3 | 22.0 | 27.4 |
| Unified science is routinely taught; changes are made to increase its impact on students | 46.9 | 37.8 | 36.6 | 24.7 |
| Unified science is taught at a refined level; alternative and additional activities to maximize the involvement and learning of students are explored | 36.8 | 44.4 | 24.4 | 23.3 |

Source of Data

2. Basis for unified science instruction: PDT-38

Which forms the primary basis of your science instruction?

| | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| Unified Science Taxonomies | 15.2 | 46.9 | 47.6 | 26.4 |
| Unified Science Teacher Guides | 55.4 | 24.5 | 9.5 | 13.9 |
| Science textbooks | 12.9 | 16.3 | 26.2 | 29.2 |
| Teacher's/student's background and interest | 5.2 | 2.0 | 7.1 | 13.9 |
| Other sources | 1.4 | 6.1 | 2.4 | 9.7 |

Taken together these results indicate that:

a. Over 95 percent of elementary and middle school teachers report average to full implementation of unified science. In junior and senior high schools the percentages are slightly higher than 75 percent.
b. A similar pattern is true for teachers' descriptions of how unified science is taught. While over 95 percent of elementary and middle school teachers report teaching unified science at least at the beginning level where most of the teachers' attentions are focused on managing and organizing the course, this minimum level is reported by 83 and 75 percent of the junior and senior high school teachers, respectively.
c. Finally, elementary and junior high school teachers use unified science taxonomies and teacher guides as the primary basis of their instruction. Only 40 percent of of senior high school teachers do so. Other sources teachers use as a basis for their instruction are library and media resources, ditto books or worksheets, and work-a-texts (specifically Cambridge Work-a-Text)

3. The average length of science lessons: PDT-44

| Length of Science Lesson | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| 15 min. or less | 8.9 | 0 | 0 | 1.3 |
| 16-25 minutes | 21.0 | 0 | 2.3 | 2.6 |
| 26-35 minutes | 40.9 | 2.0 | 2.3 | 5.3 |
| 36-45 minutes | 24.7 | 38.0 | 34.9 | 36.8 |
| More than 45 min. | 4.5 | 60.0 | 60.5 | 53.9 |

At the elementary school level, 65 percent of the teachers report that their daily science lesson is between 26 and 45 minutes in length. More than half of the secondary teachers report lessons longer than 45 minutes; more than a third report that daily science lessons last 36 to 45 minutes.

4. Should the amount of time devoted to unified science change? PDT-45

Most teachers reponded that the amount of time devoted to daily unified science instruction should remain the same as shown below.

| Amount of time alloted for unified science instruction: | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| should increase | 6.2 | 8.0 | 2.4 | 2.8 |
| remain the same | 88.4 | 88.0 | 73.8 | 65.3 |
| decrease | 5.1 | 4.0 | 23.8 | 30.6 |

Additionally, the above table shows that almost 25 percent of junior high teachers and 30 percent of senior high teachers believe that the time allotted for daily unified science instruction should decrease.

Source of Data

D. TO WHAT DEGREE DO TEACHERS ENDORSE UNIFIED SCIENCE? HOW SUCCESSFUL ARE THEY AT TEACHING IT?

**Results:**

Teachers responded to specific items which addressed these issues.

1. Acceptance of unified science: PDT-83

To what degree do you accept unified science as an organizational and instruction approach to science?

| | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| I endorse it completely | 12.8 | 18.4 | 7.0 | 1.4 |
| I accept it in general | 51.2 | 32.7 | 16.3 | 8.3 |
| I accept it with reservations | 31.3 | 28.6 | 34.9 | 34.7 |
| It is questionable | 3.8 | 8.2 | 25.6 | 25.0 |
| It is unacceptable | 0.5 | 12.2 | 16.3 | 30.6 |

2. Success of teaching unified science: PDT-84

Overall, how successful have you been teaching unified science?

| | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| Very successful | 18.2 | 28.9 | 14.6 | 4.8 |
| Usually successful | 49.3 | 46.7 | 34.1 | 29.0 |
| Of average success | 30.8 | 22.2 | 31.7 | 50.0 |
| Usually unsuccessful | 1.4 | 0 | 17.1 | 8.1 |
| Very unsuccessful | 0.3 | 0 | 2.4 | 8.1 |

Teacher's responses to these items indicate:

a. While over 50 percent of the elementary and middle school teachers endorse unified science in general or completely, less than 25 and 10 percent of the junior high teachers, respectively, do so. More than 50 percent of the senior high school teachers responded that unified science is questionable or unacceptable. The most common reasons given for its lack of acceptance are: unified science needs revision, it does not provide for the scientific needs of the average person, it is too diversified for teachers to teach, and there is too much material to cover.

b. Despite teachers' responses relative to their endorsements of unified science, over 97 percent of elementary and middle school teachers and more than 80 percent of junior and senior high teachers report average or more success in teaching it. Teachers who report little success in teaching unified science list lack of resources as the primary reason.

F. TO WHAT DEGREE IS EACH UNIFIED SCIENCE PROFICIENCY LEVEL OBJECTIVE TAUGHT?

Unified science was designed as a continuous progress program. The practice at the elementary level, however, has been to designate certain proficiency levels to be taught at specific grade levels. Variable patterns and time allotments set by individual schools as well as imbalances in the number of Proficiency Level Objectives assumed for each level made it difficult for schools to teach all the Proficiency Level Objectives at a particular level. Therefore, specific proficiency level objectives were labeled as priority objectives, others were identified as secondary to be handled as options.

**Results:**

1. Proficiency level objectives taught by grade: TYP PDT-85

Teachers were asked to report the Proficiency Level Objectives taught during the 1980-81 school year by grade. Reported below are the percentages of teachers responding to this item who completed priority and secondary objectives.

Source of Data

| Grade | Number of Teachers Responding | Percent of Teachers Completing Proficiency Level Objectives | |
|---|---|---|---|
| | | Priority | Secondary |
| K | 32 | 91% | No secondary obj. |
| 1 | 57 | 85% | No secondary obj. |
| 2 | 61 | 66% | 54% |
| 3 | 59 | 70% | 24% |
| 4 | 65 | 72% | 33% |
| 5 | 57 | 72% | 42% |
| 6 | 45 | 68% | 23% |
| 7 | 28 | 92% | No secondary obj. |
| 8 | 54 | 41% | No secondary obj. |
| 9 | 36 | 71% | No secondary obj. |
| 10 | 26 | 57% | No secondary obj. |

These percentages suggest that:

a. Although most teachers cover the priority proficiency level objectives, not all teachers do.
b. In grade eight, only 41 percent of the teachers responding teach the proficiency levels designated for that grade.
c. Secondary objectives generally are taught by less than 50 percent of the teachers responding.
d. At each grade some teachers indicate that proficiency level objectives above or below those designed for the grade are taught.
e. Other responses than proficiency level objectives made by teachers were that a textbook is taught rather than objectives or indicate new units introduced since unified science (such as dental, health, nutrition, or the drug unit).

F. WHAT INSTRUCTIONAL STRATEGIES AND TECHNIQUES ARE CURRENTLY BEING USED IN THE SCIENCE PROGRAM?

**Results:**

The answers to the question are available through the staff survey, consultant's report, and a sample of lesson plans and tests submitted by teachers.

1. Percentages of time teachers allot to specific scientific emphasis: PDT-39 to 43

| | Less than 20% | 20-40% | 40-60% | 60-80% | More than 80% |
|---|---|---|---|---|---|
| Scientific facts | 11.5 | 35.0 | 29.3 | 16.9 | 7.4 |
| Scientific concepts | 7.2 | 38.4 | 29.3 | 17.0 | 8.1 |
| Scientific theories and laws of natural phenomenon | 40.9 | 35.3 | 12.9 | 7.3 | 3.7 |
| Process of inquiry | 28.9 | 35.2 | 19.9 | 11.2 | 4.8 |
| Scientific literacy | 32.8 | 30.2 | 20.9 | 9.9 | 6.2 |

These percentages reveal that the largest percentage of time is devoted to scientific facts and concepts. Less than 40 percent of instructional time deals with scientific theories, laws of natural phenomenon, the process inquiry or scientific literacy, according to the staff's responses.

2. Lesson plans and tests:

These findings reflect similar conclusions presented by the consultants earlier in this report. In addition, an examination of lesson plans and tests developed for both unified science and secondary elective courses reveal the following:

Source of Data

a. Lesson plans. As discussed under procedures 338 objectives from lesson plans were categorized using the cognitive learning outcomes proposed by Bloom. The pecentage of verbs within objectives falling into each category were: LP

| Category | Percentage of Objectives |
|---|---|
| Knowledge | 31% |
| Comprehension | 29% |
| Application | 14% |
| Analysis | 9% |
| Synthesis | 1% |
| Education | 1% |
| Other | 15% (These were statements describing activities in which students would participate, e.g., perform an experiment, assemble, dissect). |

b. Semester Exams. Semester exams for each senior high school course were submitted for examination as described under procedures. Reported below are the percentage of items by subject area falling into each of the categories of cognitive learning outcomes. TMT

| | Learning Outcome | | | | | |
|---|---|---|---|---|---|---|
| Course | Knowledge | Comprehension | Application | Analysis | Synthesis | Evaluation |
| Unified Science | 97 | 2 | 0.3 | 0.1 | 0 | 0 |
| Biology | 95 | 2 | 0.9 | 2 | 0 | 0 |
| Chemistry | 39 | 25 | 25 | 11 | 0 | 0 |
| Physics | 35 | 32 | 31 | 1 | 0 | 0 |

It is quite clear from four sets of data (consultants, staff survey, lesson plans, and semester tests) that:

a. Most emphasis in instruction deals with learning (memorizing) and understanding facts, concepts, and the general body of knowledge known as science.
b. Lesson plans may place some emphasis on higher levels of outcomes (such as application and analysis) but it is not reflected in tests for unified science and biology.
c. Chemistry and physics place more emphasis on higher levels of learning outcomes (application and analysis) than do unified science and biology.
d. None of the lesson plan objectives or test items fell within the domains of synthesis and evaluation according to the classification done for this evaluation.

## G. WHAT INSTRUCTIONAL TECHNIQUES DO TEACHERS USE?

**Results:**

1. Instructional strategies used: PDT-46 to 54

The table below presents the percentage of teachers who report using each of the strategies frequently to always.

| Instructional Strategy | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| Teacher presentation | 87.6 | 72.9 | 73.8 | 65.2 |
| Textbook readings | 31.5 | 47.0 | 59.6 | 51.4 |
| Homework | 4.2 | 49.0 | 59.5 | 27.2 |
| Workbook or other activities | 35.0 | 53.0 | 64.3 | 58.8 |
| Teacher lab demonstrations | 33.8 | 27.1 | 33.3 | 31.4 |
| Student laboratory activities | 20.0 | 24.5 | 42.9 | 23.9 |
| Learning stations | 15.8 | 18.4 | 9.3 | 11.6 |
| Independent work | 36.8 | 31.9 | 16.3 | 17.2 |
| Group/Individual projects | 36.1 | 24.4 | 9.3 | 11.4 |

These responses indicate that:

a. The most frequently used instructional strategy is teacher presentation.
b. Less than half the teachers report using teacher lab demonstrations or student laboratory activities frequently or always. Fewer than five percent of the elementary teachers report assigning homework in science frequently or always.
c. Independent work and group/individual projects occur more frequently in elementary/middle schools.

Source of Data

d. Teachers who report that they seldom or never use a specific strategy give the following explanation for their responses:
   1) Textbook readings. Texts are unavailable, too difficult, or inappropriate for the specific grade level.
   2) Homework. It is difficult to give homework in grades K and one. It is difficult to assign homework without enough texts or other materials.
   3) Workbooks or other supplementary activities. They are not available.
   4) Teacher laboratory demonstrations. Uses primarily hands-on activities for students.
   5) Student laboratory activities. The class is too large, room is too small, lack of equipment, and lack of background for students in laboratory.
   6) Learning stations. It does not fit with the physical layout of the room, not enough time to set them up, and students do not learn from them.
   7) Independent work. It is used only with gifted and talented.
   8) Group/individual Projects. They are used just for science fairs.

## H. WHAT DO TEACHERS USE AS A SOURCE IN INSTRUCTIONAL PLANNING?

**Results:**

The table below presents the percentage of teachers who report using each of these sources frequently or always.

1. Basis for instructional planning:

PDT-62 to 65

| Source | Elem. | Middle | JHS | SHS |
|---|---|---|---|---|
| Taxonomy of Objectives | 60.0 | 81.3 | 60.5 | 65.3 |
| Teacher's Guide | 88.4 | 52.1 | 23.3 | 35.2 |
| Textbooks | 52.4 | 75.0 | 86.1 | 75.3 |
| Other Sources | 57.5 | 54.4 | 69.1 | 65.2 |

a. The primary source for instructional planning for unified science varies by level. Elementary teachers use Teachers' Guides, middle school teachers use the Taxonomy of Objectives, and junior and senior high teachers use textbooks.
b. More than half of the teachers report using each source frequently to always with the following exception: About one-fourth of junior high and one-third of senior high teachers use the unified science teacher guides frequently to always.
c. The other source most frequently mentioned are films and other media resources.
d. Teachers who report using the Taxonomy of Objectives or Teachers' Guides for planning seldom or never report that these materials are not available, are not necessary for planning, are poor guides, or do not meet students' needs.

## I. WHAT STEPS CAN BE TAKEN TO IMPROVE THE SCIENCE PROGRAM AND ITS DELIVERY?

The responses to this question elicited suggestions for changes related to the curriculum, unified science materials, texts, the staff, students, and other concerns. Because teachers' responses to this question and a later item which invited them to share anything else about unified science were similar, the responses to the two questions have been combined. Following each suggestion or comment is the number of times the comment was made.

1. Unified Science Program

PDT-86 to 87

a. Revise materials to make them more realistic and appropriate for students' ages, abilities, interests, and experiences. (51)
b. Confine unified science to grades K-8, teach earth space science and biology in grades 9 and 10. (46)
c. Cut down the amount of material that must be covered in specific grades (e.g., grade 3). (36)
d. Refine the organization and sequence of proficiency level objectives to increase the consistency from one level to the next. (36)
e. Reorganize proficiency level objectives by science disciplines (earth, physical, life science). (33)
f. The program is superior to traditional programs, no improvement is necessary, I endorse it, best most complete program in the county, unified science is successful. (33)

Source of Data

g. Revise unified science, rewrite it, completely overhaul it, (use experts or teachers who have taught it). (32)
h. Update unified science, add new materials and discoveries. (17)
i. The continuation of unified science cannot be justified, drop it, it's a nice concept that doesn't work in reality. (14)
j. Add new topics to unified science. (9)
k. Increase the diversity in topics, there is too much repetition. (9)
l. Teach unified science in grade 9 only to low ability or disadvantaged students. (9)
m. Remove the spiral, self-pacing, and continuous progress components from unified science. (5)
n. The following comments regarding the unified science program were suggested by five or fewer staff members: the program needs more teacher input; increase amount of materials to be covered in grade 1; less science emphasis is needed in primary grades, more emphasis on basic skills is needed; restate the philosophy of unified science to make it more realistic; the sequence of proficiency level objectives makes it easy for students to understand; unified science needs more structure, what is to be taught at each grade should be specified; unified science needs less structure and more flexibility; keep unified science only through grade 6; provide more individualization though small group activities; incorporate the scientific method into other content areas; I enjoy the flexibility inherent in unified science; hands-on activities are dangerous in elementary school; progress in terms of proficiency levels difficult to measure and is inconsistent with county grading policies; the program was introducted more for the sake of innovation than for education importance; the objectives should be more challenging; elementary science would not occur without unified science; and emphasize skills more.

2. <u>Unified science materials (taxonomies and teacher guides)</u>: PDT 86 to 87

a. Revise, update and expand teacher guides and lists of resources. Specific suggestions include: (119)
   1) Include experiments which do not require elaborate equipment and chemicals
   2) Clearer pictures or diagrams in the PLO's
   3) Better, more realistic activities for each objective
   4) Review the pre- and post-tests in teacher guides
   5) More concrete materials for primary PLO's
   6) More hands-on, inquiry, process activities
   7) Updated lists of materials
   8) Activities for slower students
   9) Enrichment activities for each PLO
   10) Have ditto masters already prepared
b. Provide all of the necessary science materials and equipment to schools (76)
c. Provide more updated and diverse audiovisual materials, media, pictures, and supplies (24)
d. Provide funds to schools for science materials (20)
e. The following suggestions were made by five or fewer staff members: I need access to teachers' guides; teachers need more reference and research books; correlate teachers' guides to textbooks; more shelf space in classrooms to store science materials; the materials are too costly; and too many materials are needed

Source of Data

3. Textbooks: PDT 86 to 87

   a. Find or develop one (a better) unified science textbook that correlates proficiency level objectives and grade levels (114)
      One text for each child (23)
      More texts for home/school communication (9)
   b. Supplemental textbooks (8)
   c. Use textbooks as the primary program with proficiency level as secondary (5)
   d. Adopt a core of four or five textbooks (1)
   e. Identify materials for students with special needs (1)

4. Staff PDT 86 to 87

   a. Need inservice workshops which focus on teaching demonstrations, content, materials, and activities for the staff (21)
   b. Need more time to plan and prepare (19)
   c. Provide a teacher resource team for each grade level (7)
   d. I need more time to teach science (7)
   e. Each of the remaining comments was given by five or fewer teachers: get more input about unified science from teachers; supply aides for teachers; accommodate teachers' schedules to allow for sharing equipment, films, and materials; the success of science is due to teachers not the unified science program; elementary teachers should teach more science; I'm trained to teach biology, not unified science; most teachers are comfortable with the program; I need smaller classes to implement unified science; need more departmentalization at the elementary level; need better training of teachers in science; teachers should not have to write the program; all teachers should follow the program; fire some incompetent teachers; realistic class sizes; get total (teacher) support of unified science or change it; unified science is difficult to teach in double grades (e.g., 3-4); unified science is not taught uniformly across the county; unified science is the reason for the low interest in science; it is very clear to teachers what objectives are to be taught and achieved.

5. Students PDT 86 to 87

   a. Each of these comments was made by five or fewer teachers: Youngsters are highly motivated and enjoy science; children already know the material in the proficiency level objectives; I'm worried as a parent that it's bad for children; kids have trouble jumping from one subject to the next; students don't see the overall structure of unified science; students should be required to complete one major project per semester.

Source of Data PDT 86 to 87

6. Other Comments:

These general comments do not fit into the above categories of comments. All were made by five or fewer teachers. Unified science is a nice idea on paper, but with large classes, not enough time, and old equipment it won't work; too much loose paperwork; (a student's) records often say unified (science) when it really wasn't taught; we use it (unified science) as a vehicle for developing study skills, reporting skills, and research skills; make sure the lower grades follow the curriculum; mandate all schools to teach it; (need) more interest from the administration to improve the science curriculum, it needs to be taught in a laboratory; I need a xerox machine or ditto masters; follow the suggested lessons put out by the Special Education Department.

## SUMMARY, OBSERVATIONS AND RECOMMENDATIONS

### I. SUMMARY AND OBSERVATIONS

This evaluation of the science program was designed to answer a set of broad research questions. The questions relate to the science curriculum, students' achievement in and attitudes toward science, and science instruction. The Results section of this report answers these questions by integrating data provided by consultants; graduates of and students in Anne Arundel County Public Schools; principals, science department chairpersons, and science teachers; standardized achievement tests; and other data previously collected that was assembled for this evaluation report.

Realizing that individualization exists in each student, principal, teacher, school and consultant, the following observations in the data are offered to serve as a summary of this evaluation report. More specific data on any observation can be found in that portion of the Results section that addresses the issue.

#### A. THE SCIENCE CURRICULUM:

1. The unified science program reflects an immense organizational effort by an academically and technically capable staff. The basic constructs and philosophical base of unified science and scheme for scientific literacy are excellent beginnings for building a science program.

2. The format for unified science provides for revisions and updating as needed. Suggestions for revision are offered to update the program and to correct limitations inherent in the implementation of unified science.

3. The Taxonomies of Objectives and Teachers' Guides place too much emphasis on subject matter content, "scientific facts", and too little emphasis on the processes of science, how scientific knowledge is produced, and the discipline of reasoning.

4. Students may be unaware of the unifying themes of unified science even after completing all proficiency level objectives. This may occur because unified science is not taught as a continuous progress curriculum; not every proficiency level objective is required to be taught (priority and secondary objectives). While 81.1 percent of elementary teachers responded that completing all 21 proficiency levels was important, more than 50 percent of junior and senior high school teachers responded that completing all levels was slightly important or not important at all. Middle States evaluations echoed this position by recommending flexibility in the requirement to complete all unified science levels to allow students to enroll in other high school electives.

5. As revisions are considered and made in the unified science program, more attention should be given to matching the program with the developmental level of students and to the special characteristics and needs of students (such as gifted/talented or special education students).

6. Teaching unified science places high demands on teachers to become competent in all phases of science content and science instruction. The Teachers' Guides lack the specificity that teachers may need. Consultants and teachers report that there is too much material for teachers to cover. Finally, individualizing the program for students depends upon the teacher and is not built into the curriculum materials.

7. Teachers report needing three or more texts to teach unified science. In addition there is a need for science texts for students with poorly developed reading skills. The staff reports that teachers do not have Teachers' Guides for proficiency levels they are responsible for teaching.

8. The laboratory supplies and equipment necessary to teach unified science are available in sufficient quantities according to sixty percent of middle schools. Fifty percent of junior high, 40 percent of elementary, and 25 percent of senior high school teachers report this availability of materials and equipment. Most teachers (70%) report that most or all equipment is in working order. The condition of science facilities to implement unified science is variable. While 62 percent of middle school teachers report their facilities to be adequate, this is true of only 40 percent of junior high teachers. However, 60 percent or more teachers rate the facilities to be safe.

#### B. THE STUDENT - PERFORMANCE, ATTITUDES, AND LATER SUCCESS

1. The five courses most frequently elected in senior high school are unified science 9, unified science 10, biology, chemistry, and physics. About 50 percent of the students earn beyond the two credits required for graduation.

2. Secondary elective science courses are available for academic, average, and below average students. Although several exceptions were noted, students generally enroll in science courses designed for their ability/achievement levels.

3. The perceptions and attitudes of graduates about their science education reflect whether or not they are employed in a science-related career. More than 50 percent of the graduates surveyed report satisfaction with their science education in the Anne Arundel County Schools; three-fourths of graduates in science-related careers are satisfied. Graduates report that their science classes were interesting, were seldom either too easy or too difficult, focused on memorizing facts, and covered material that was different from what was learned in other classes or things they learned outside of school. Graduates also report that they had little opportunity to decide what would be taught in science class and the method by which it would be taught.

4. Individuals employed in science-related careers and males view science education as more useful and participate in more science-related activities than do females and those in non-science careers.

5. Although graduates believe that science has an impact on solving world problems, except in energy waste and accidents, they feel that they personally play a little role in solving such problems.

6. On standardized achievement tests of general science and high school science courses, a sample of students countywide scored at the following national group percentiles:

| | | |
|---|---|---|
| General Science | | |
| Grade 4 | | 82 |
| Grade 6 | | 82 |
| Grade 9 - | Biological Science | 68 |
| | Earth Science | 68 |
| | Physical Science | 76 |
| High School Biology | | 41 |
| High School Chemistry | | 43 |
| High School Physics | | 76 |

C. SCIENCE INSTRUCTION:

1. Seventy-five percent of the staff members who responded to this survey possess advanced professional certification. This means that they have met the Maryland degree/inservice credit requirements. Of the 568 surveys returned, there were 644 indications of interest in participating in the various science inservice workshops offered in Anne Arundel County. Both teachers and consultants responded that teacher inservice is vital to the success of unified science.

2. Teachers' responses to the various questions asked about unified science differ by level of school: elementary, middle, junior high, or senior high school. Elementary and middle school staff members rate each of the following higher than junior and senior high school staff members: preparation to teach unified science, degree of implementation of unified science, and use of unified science Taxonomies and Teachers' Guides for instructional planning.

3. The responses to survey items related to the learning outcomes of science instruction in the classroom reveal that the primary focus of science instruction is learning and understanding scientific facts and concepts. Less emphasis is placed on higher level cognitive processes. This finding was also presented by consultants and is reflected in the lesson plans and semester examinations submitted by teachers.

4. When asked to what degree they endorse unified science, over 50 percent of elementary and middle school teachers responded that they endorse it generally or completely; 50 percent of senior high school teachers responded that the concept of unified science is questionable or unacceptable.

## II. RECOMMENDATIONS

The following recommendations for revising the science program were offered by the consultants and staff members (principals, science department chairpersons, and unified science teachers).

A. CONSULTANTS:

1. That in-service training programs be continued and expanded with proper coverage of such topics as:

   a. Up-to-date science subject matter and how it can be integrated into the nature of unified science
   b. How to best use the curriculum materials already prepared
   c. Development of teacher questioning skills
   d. The purpose and use of the unifying themes
   e. Skills of teaching science from an "inquiry" approach and less from a "body of knowledge" approach
   f. Furnish specific experiences with selected core activities

2. That more attention has to be given to authentic "hands-on process-oriented" science student activities and less emphasis be given to verbal "parroting" of science information.

3. That more attention be given to the student going on beyond memorization and simple recall to a sense of inquiry and discovery, problem-solving, integration of scientific information and interpretation of data.

4. That there be more "open-ended" experiments and experiences added to the curriculum in which students carry out their observations and data collection on near-by materials that they actually physically interact with and not just see on paper or on film.

5. That a study be made of the materials to determine if the spiraling levels match up with the developmental levels of the students and that the various learning theories be applied as appropriate.

6. That there be less emphasis on "fill in the blank" workbooks and more emphasis put on the higher levels of Bloom's Taxonomy including application, analysis and synthesis of science subject materials.

7. That the anticipated goals of individualization still be pursued but that in addition to teacher workshop sessions on individualizing instruction there should be a rewriting of the materials to truly reflect student individualization activities and better "road maps".

8. That any of the objectives not presently measureable be rewritten in a form so that one can measure their accomplishments.

9. Other action verbs should be added to the Semester Course Objectives Taxonomies so that describe is no longer so dominate and that there be more use of compare and constrast.

10. Material should be added that explains that basis of the pre-tests and the post-tests should be rewritten so that there is less dependence on the teacher for their interpretation.

11. More attention should be given to the pre-tests and the post-tests so that they are geared to the objectives and be functional so that they allow the teacher to key individual students into related measureable objectives.

12. That any rewritten or newly written material have less emphasis on verbal learning and more on "doing science" rather than "reading about" or "listening to" science.

13. That serious consideration be given to the problems and benefits of curriculum coordination so that the unifying themes become self-evident to the students.

14. That the teachers' guides be made more specific and that this be particularly done in regard to the teaching of the unifying themes.

15. That considerable thought be given to reducing the total number of objectives that a student must meet by combining closely related ones and selecting only those that are considered highly desireable.

16. That more alternative activities be written to meet an objective and these activities be more science process oriented with more opportunity for true science investigation.

17. That any changes or added material strongly encourage the discipline of reasoning and the maximum of student creativity.

18. That there be a serious attempt at identifying science and science-related careers to students whenever appropriate with information on where to find additional information on each career.

19. There exists a need for a mechanism of continuous revision as well as for an immediate up-dating of the science content.

B. PRINCIPALS, SCIENCE DEPARTMENT CHAIRPERSONS, AND UNIFIED SCIENCE TEACHERS:

(Recommendations are listed only if they were offered by 10 or more respondents)

1. Unified Science Program

   a. Revise the program and materials to make them more realistic and appropriate for students' ages, abilities, interests and experiences. (Recommended by 51 respondents)
   b. Restrict unified science to grades K through 8 and teach earth-space science and biology in grades 9 and 10. (46)
   c. Cut down on the amount of material that must be covered in specific grades. (36)
   d. Refine the organization and sequence of proficiency level objectives to increase the consistency from one level to the next. (36)
   e. Reorganize proficiency level objectives by science disciplines (earth, physical, life science) (33).
   f. Keep unified science; it is superior to traditional programs. No improvement is necessary. (33)
   g. Use experts and teachers who have taught unified science to make any revisions in the program. (32)

h. Update unified science by adding new materials and discoveries. (17)
i. Discontinue unified science; it cannot be justified. Unified science is a nice concept that does not work in reality. (14)

2. Unified Science Materials (Taxonomies of Objectives and Teachers' Guides)

a. Revise, update and expand the Teachers' Guides and lists of resources (recommended by 119 respondents)

Specific recommendations include:
- o Include experiments which do not require elaborate equipment and chemicals;
- o Provide clearer pictures and diagrams for each PLO;
- o Provide better, more realistic activities for each objective;
- o Revise the pre- and post-tests in the Teachers' Guides;
- o Construct more concrete materials for the primary grade PLO's;
- o Provide more hands-on, inquiry, process activities;
- o Provide activities for slower students;
- o Provide enrichment activities for each PLO;
- o Provide ditto masters already prepared.

b. Provide all the necessary science materials and equipment to schools. (76)
c. Provide more updated and diverse audiovisual materials, media, pictures, and supplies. (24)
d. Provide additional funds to schools to purchase science materials, equipment and supplies. (24)

3. Unified Science Textbooks:

a. Find or develop a unified science textbook that correlates proficiency level objectives with grade levels (recommended by 114 respondents).
b. Provide a text for each child. (23)

4. Inservice and planning time

a. Provide more inservice workshops which focus on science teaching demonstrations, science content, materials, and activities. (Recommended by 21 respondents).
b. Provide more time to plan and prepare for science instruction. (21)

## III. DISCUSSION OF THE MODEL AND CONCLUDING OBSERVATIONS

During the 1980-81 school year the Office of Research was assigned the task of designing an evaluation of the Science Program, collecting and analyzing data, and preparing a report for the Superintendent of Schools and Board of Education. This process is finished with the completion of this report.

The model upon which this evaluation was designed appears to have worked well. It provided for a comprehensive examination of a curriculum program, provided for all staff involved with science education to participate both in the determination of questions to be addressed as well as responding to specific evaluation questions. At the same time the model minimized requests for information at the school level through the use of sampling techniques, the use of information stored on the Anne Arundel County School data base, and the aggregation of existing information. The consultants commended the system for the magnitude and scope of the evaluation process, it appears that few if any school systems embark upon a program evaluation this comprehensive. While improvements and refinements in the model will undoubtedly occur with each implementation, the general model worked well and appears to be a sound method for guiding program evaluation.

The science evaluation data largely speaks for itself. At the risk of oversimplying the patterns evident in the data a few observations can be made. The data simultaneously exhibit consistency and contrast. Consistency is evident in the following ways: every recommendation made by the consultants was also made independently by the science teachers; elementary, middle, junior high, and senior high school teachers responded consistently across all the survey items to which they responded. Contrast is reflected in the high performance of students on the general science test (grade 4, 6, and 9) and the listing of weaknesses of unified science. Contrast is also evident in recommendations for unified science made by staff: while some teachers recommend discontinuing unified science, others recommend no changes. Most teachers recommend specific changes rather then either of these extremes.

## ANNE ARUNDEL COUNTY PUBLIC SCHOOLS

## SCIENCE EVALUATION

The following questions are to be addressed by each consultant as he/she examines the science curriculum materials.

I. Answer these questions for the total curriculum.

A. Are the concepts, facts, theories, natural laws, and processes of inquiry addressed by the current science curriculum appropriate for the decade of the 1980's?

B. Are the objectives of the science curriculum appropriate to develop scientific literacy in students?

C. Does the curriculum reflect the current developments in science and science education?

D. Does the curriculum meet students' educational needs?

II. Answer these questions about Unified Science, Proficiency Levels I through XXI. Use the Taxonomies of Objectives, Teachers Guides, and Supplementary Materials.

A. The Unified Science Curriculm
1. Is the organization and structure of the curriculum consistent with current theories of learning and instruction?
2. Do the objectives to be met by the curriculum match the developmental characteristics of students in grades kindergarten through ten?
3. Does the curriculum allow students to organize their learning based upon previous knowledge and experiences?
4. Are the suggested activities in the teachers guides appropriate to reach the objectives of Unified Science?
5. Are the materials and equipment suggested for specific activities appropriate to reach the objectives of Unified Science?

B. Teaching Unified Science
1. How easy or difficult is it for teachers to teach Unified Science?
2. Given the current nature of teacher education in science, what steps would you recommend to prepare teachers to teach Unified Science?
3. Are the demands made upon teachers to implement Unified Science reasonable?
4. Unified Science is described as a program which provides for the continuous progress of students, individualization, and self-pacing. Please react to the demands on the teacher to implement these components of Unified Science.

C. The Student

1. How well does Unified Science meet the diverse needs of the total student population (e.g., students who are gifted/talented, college-bound, or noncollege-bound, students receiving special education services, students preparing for a science-related career, or students who will elect additional science courses after completing Proficiency Level XXI?

III. Answer these questions about the elective, semester courses.

A. Will students who complete Proficiency Level XXI have the necessary prerequisites for elective courses? Use the Semester Course Taxonomies.

B. Do the elective courses allow students to organize their learning based upon their previous knowledge and experiences?

C. Is the organization and structure of elective courses consistent with current theories of learning and instruction?

D. Are the course objectives appropriate for the characteristics of the students who elect the course?

E. Does the array of electives meet the diverse needs within a student population (e.g., students who are college-bound, noncollege-bound, gifted/talented, science-career oriented, or nonscience-career oriented)?

F. Are the demands made upon the teacher to implement these courses reasonable?

**ANNE ARUNDEL COUNTY PUBLIC SCHOOLS**
**SCIENCE EVALUATION**
**SCIENCE CURRICULUM MATERIALS**

The following science curriculum materials are included to be examined in addressing the evaluation questions:

UNIFIED SCIENCE, KINDERGARTEN THROUGH GRADE 12.

Proficiency Levels I - XXI
Taxonomy of Objectives
Proficiency Levels I - VI
VII - XII
XI - XVI (Middle School)
XVII - XXI

Teachers Guides
Proficiency Level

| | |
|---|---|
| III | PLO 3 |
| V | PLO 2 |
| VII | PLO 9 |
| XIII | PLO 5 |
| IX | PLO 4 |
| XI | PLO 4 |
| XV | PLO 7 |
| XVI | PLO 10 |
| XIX | PLO 3 |

(Teachers Guides represent a selection of nine, representative PLO's across the span of proficiency levels.)

Supplementary Materials and Resource List
Proficiency Levels XIX - XXI

Unified Science Process Scheme
Supplementary Guide, Component Skills
Sample Activities

SEMESTER COURSE TAXONOMIES

| COURSE | STUDENTS COURSE DESIGNED FOR |
|---|---|
| Biology 260 | Average and academic |
| Botany | Average and below average |
| Zoology | Academic |
| Organic Chemistry | Academic |
| History of Science | Average |
| Advanced Chemistry | Academic |
| Environmental Science | Average and below average |
| Geology | Average |
| Oceanography | Average |
| Genetics | Academic |
| Microbiology | Academic |
| Human Biology | Below average |
| Ecology | Average |

Note: These are course taxonomies for thirteen of the fifteen semester courses where a taxonomy has been developed. The taxonomies for Applied Science and the Animal Kingdom were not available when this packet was assembled. For the remaining science elective courses, taxonomies or curriculum guides are either the textbook (e.g., BSCS Biology or PSSC Physics) or have not been developed. Answer questions based upon this selection of materials.

Attachment B

**ANNE ARUNDEL COUNTY PUBLIC SCHOOLS**

**SCIENCE EVALUATION**

**Survey of Fomer Students**

Dear Former Student:

At the request of the Superintendent of Schools and the Board of Education, the Office of Research is coordinating an evaluation of the Anne Arundel County Public School's Science Program. One part of the evaluation involves asking former students a series of questions about this program. Your name has been randomly selected from students graduating from the Anne Arundel County Public Schools over the past five years. Would you please take a little time to complete this survey. All information will be kept confidential and will be used to help the science program work to its best to meet the needs and interests of students. Please return the completed survey in the attached envelope within seven (7) days.

Thank you,

Timothy R. Dangel
Coordinator of Research

**DIRECTIONS:** PLEASE GIVE THE REQUESTED INFORMATION BY CHECKING THE MOST APPROPRIATE RESPONSE FOR EACH ITEM OR BY WRITING A COMMENT WHERE IT IS REQUESTED. (THE NUMBERS AND LETTERS IN PARENTHESES ARE CODES TO PERMIT A COMPUTER ANALYSIS OF THE SURVEY. YOU MAY IGNORE THEM.)

Sex: ___Male ___Female

1. What is your current employment or educational status? (Check all that apply.)

___(A) Employed full-time
___(B) Employed part-time
___(C) Enrolled in a junior/community college
___(D) Enrolled in a technical/trade/business school
___(E) Enrolled in a four-year college or university

2. ___(A) College graduate
___(B) Military
___(C) Homemaker
___(D) Unemployed
___(E) Other (explain)

3. If you are employed, what is the nature of your employment?_____
_____

4. In general, how satisfied are you with your science education?

___(A) Very satisfied
___(B) Satisfied
___(C) Neither satisfied nor dissatisfied
___(D) Dissatisfied
___(E) Very dissatisfied

5. How well satisfied were you with the number and variety of science courses offered in high school?

___(A) Very satisfied
___(B) Satisfied
___(C) Neither satisfied nor dissatisfied
___(D) Dissatisfied
___(E) Very dissatisfied

6. Do you wish that you had taken additional science courses in high school?

___(A) Yes
___(B) No

If Yes, what subjects or courses would you like to have studied?
_____
_____

**Items 7 - 13: For you, how often were the things you studied in science class:**

7. Boring

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

8. Interesting

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

9. Too Difficult

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

10. Too Easy

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

11. Things you already learned in school

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

12. Things you already learned outside of school

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

13. Facts you had to memorize

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

**Items 14 - 18: In science classes, how often have you done each of the following:**

14. Chosen a topic or project yourself

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

15. Chosen the way you wanted to learn

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

16. Selected the order in which you studied science topics

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

17. Gotten to work at your own speed

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

18. Gotten to decide for yourself when you were ready to hand in assignments and take tests

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

**Items 19 - 24: Tell how much you agree or disagree with each of the following statements regarding science classes in general:**

19. Science classes are useful

___(A) Strongly agree
___(B) Agree
___(C) No opinion
___(D) Disagree
___(E) Strongly disagree

20. The things you learn in science classes have nothing to do with the real world

___(A) Strongly agree
___(B) Agree
___(C) No opinion
___(D) Disagree
___(E) Strongly disagree

21. Science should be required in school

___(A) Strongly agree
___(B) Agree
___(C) No opinion
___(D) Disagree
___(E) Strongly disagree

22. The amount of science required in grades 9 through 12 for graduation should be increased beyond two years

___(A) Strongly agree
___(B) Agree
___(C) No opinion
___(D) Disagree
___(E) Strongly disagree

23. Much of what you learned in science class is useful in everyday life

___(A) Strongly agree
___(B) Agree
___(C) No opinion
___(D) Disagree
___(E) Strongly disagree

24. Much of what you learned in science class will be useful in the future

___(A) Strongly agree
___(B) Agree
___(C) No opinion
___(D) Disagree
___(E) Strongly disagree

**Items 25 - 32: How often have you done each of the following activities since graduating from high school:**

25. Read science articles in magazines and newspapers

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

26. Watched science shows on TV

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

27. Gone to hear people give talks in science

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

28. Read books about science or scientists

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

29. Talked about science topics with your friends

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

30. Done science projects

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

31. Worked with science-related hobbies

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

32. Visited a science museum, exhibit, display, or center

___(A) Always
___(B) Often
___(C) Sometimes
___(D) Seldom
___(E) Never

**Items 33 - 38: In solving problems since you left high school, how often have you:**

33. Done an experiment

___(A) Many times
___(B) Not very often, but more than twice
___(C) Once or twice
___(D) Never

34. Taken measurements

___(A) Many times
___(B) Not very often, but more than twice
___(C) Once or twice
___(D) Never

35. Made careful observations

___(A) Many times
___(B) Not very often, but more than twice
___(C) Once or twice
___(D) Never

36. Tried to find out more facts about a problem

___(A) Many times
___(B) Not very often, but more than twice
___(C) Once or twice
___(D) Never

37. Thought of several ways to solve a problem

___(A) Many times
___(B) Not very often, but more than twice
___(C) Once or twice
___(D) Never

38. Solved problems by using the scientific method

___(A) Many times
___(B) Not very often, but more than twice
___(C) Once or twice
___(D) Never

39. Have you taken any science courses since leaving high school?

___(A) Yes
___(B) No

40. If you answered Yes to item 39, how well did the science courses you took in the Anne Arundel County Public Schools prepare you for these courses?

___(A) I was very well prepared
___(B) I was prepared
___(C) I was unprepared
___(D) I was very unprepared

**Items 41 - 46: For each of the world problems below, tell whether or not the things you can do really can help solve these problems. As a result of your science education, do you believe that you can help solve the problems of:**

41. Pollution?

___(A) Definitely yes
___(B) Probably yes
___(C) Not sure
___(D) Probably not
___(E) Definitely not

42. Energy waste?

___(A) Definitely yes
___(B) Probably yes
___(C) Not sure
___(D) Probably not
___(E) Definitely not

43. Food shortages?

___(A) Definitely yes
___(B) Probably yes
___(C) Not sure
___(D) Probably not
___(E) Definitely not

44. Disease?

___(A) Definitely yes
___(B) Probably yes
___(C) Not sure
___(D) Probably not
___(E) Definitely not

45. Running out of natural resources?

___(A) Definitely yes
___(B) Probably yes
___(C) Not sure
___(D) Probably not
___(E) Definitely not

46. Accidents?

___(A) Definitely yes
___(B) Probably yes
___(C) Not sure
___(D) Probably not
___(E) Definitely not

**Items 47 - 53: For each of the following problems tell how much you think the application of science can help to solve the problem. How much do you think science can help:**

47. Prevent worldwide starvation?

___(A) Very much
___(B) Some
___(C) None

48. Save us from an energy shortage?

___(A) Very much
___(B) Some
___(C) None

49. Find cures for diseases?

___(A) Very much
___(B) Some
___(C) None

50. Control weather?

___(A) Very much
___(B) Some
___(C) None

51. Prevent wars?

___(A) Very much
___(B) Some
___(C) None

52. Save our natural resources?

___(A) Very much
___(B) Some
___(C) None

53. Improve worldwide communication?

___(A) Very much
___(B) Some
___(C) None

---

54. Is there anything else you would like to tell us about your experiences in the Anne Arundel County Public School's Science Program?

**ANNE ARUNDEL COUNTY PUBLIC SCHOOLS**
**OFFICE OF RESEARCH**
**STAFF SURVEY OF UNIFIED SCIENCE**

Dear Principal, Science Department Chairperson, and Teachers:

At the direction of the Superintendent of Schools and the Board of Education, the Office of Research is coordinating an evaluation of the K-12 science curriculum. One important part of the evaluation is to gather information about this program from the school staff. As a school principal, science department chairperson, or unified science teacher you are asked to respond to the specific items on this survey. All responses will be kept confidential. The information gathered will be used to help the science program work its best to meet the various needs and interests of students. Please return the completed survey via basket delivery by April 17, 1981.

Thank you,
Timothy R. Dangel
Coordinator of Research

**SECTION I**

**DIRECTIONS:** Please give the requested information by checking the appropriate response for each item or by writing a comment. (The letters in parentheses are for the computer analysis of this survey.)

School _____ School Number _____ (A-D)

How many years have you taught unified science? _____ (E-F)

How many credits of science or science education have you earned? Include all college, and graduate studies, county science inservice, and certification courses. _____ (G-H)

1. Current position

____ (A) Principal
____ (B) Science department chairperson
____ (C) Science teacher

2. What teaching certificate do you currently hold?

____ (A) Provisional Degree
____ (B) Professional
____ (C) Advanced Professional

At which of the following grades do you currently teach unified science? (Check all that apply.)

3. ____ (A) Kindergarten
____ (B) Grade 1
____ (C) Grade 2
____ (D) Grade 3
____ (E) Grade 4

4. ____ (A) Grade 5
____ (B) Grade 6
____ (C) Grade 7
____ (D) Grade 8
____ (E) Grade 9

5. ____ (A) Grade 10

---

**SECTION II**

In which of the following science inservices have you participated?
In which would you like to participate?

| Inservice | Dates Offered | Credits | Did You Participate In This Workshop? | Would You Like To Participate In A Similar Workshop In The Future? |
|---|---|---|---|---|
| Unified Science | Summer, 1973 | 1 | 6 ___ (A) Yes | 7 ___ (A) Yes |
| Individualized Science Laboratory | Summer, 1973 | 1 | 8 ___ (A) Yes | 9 ___ (A) Yes |
| Aerospace Education Workshop for Teachers | Summer, 1974 | 3 | 10 ___ (A) Yes | 11 ___ (A) Yes |
| Developing Competencies in Teaching Unified Science | Summer, 1974 | 3 | 12 ___ (A) Yes | 13 ___ (A) Yes |
| Science 7-9 | Summer, 1974 | 1 | 14 ___ (A) Yes | 15 ___ (A) Yes |
| Unified Science Workshop for Elementary Teachers | Summer, 1974 | 1 | 16 ___ (A) Yes | 17 ___ (A) Yes |
| Moving Toward Individualization and Self-Pacing in Unified Science | Summer, 1975 | 3 | 18 ___ (A) Yes | 19 ___ (A) Yes |

**SECTION II (continued)**

| Inservice | Dates Offered | Credits | Did You Participate In This Workshop? | Would You Like To Participate In A Similar Workshop In The Future? |
|---|---|---|---|---|
| Developing Instructional Materials for the Teachers of Unified Science - Area IV | Summer, 1975 | 2 | 20 ___ (A) Yes | 21 ___ (A) Yes |
| Unified Science for Elementary and Middle School Teachers | Summer, 1976 | 3 | 22 ___ (A) Yes | 23 ___ (A) Yes |
| Developing Instructional Strategies for Open Space Science | Summer, 1976 | 3 | 24 ___ (A) Yes | 25 ___ (A) Yes |
| Curriculum Development and Instructional Strategies for Unified Science | Summer, 1977 | 3 | 26 ___ (A) Yes | 27 ___ (A) Yes |
| Curriculum Development and Instructional Techniques for Earth Space Science | Summer, 1977 | 3 | 28 ___ (A) Yes | 29 ___ (A) Yes |
| Curriculum Development and Instructional Strategies for Biology Program | Summer, 1977 | 3 | 30 ___ (A) Yes | 31 ___ (A) Yes |
| Marine Science Program | Spring, 1979 | 1 | 32 ___ (A) Yes | 33 ___ (A) Yes |
| Unified Science Approach in Elementary Science Education | Fall, 1979 | 3 | 34 ___ (A) Yes | 35 ___ (A) Yes |

**SECTION III**

**Directions: Teachers -- answer each question as it applies to your classroom situations. Principals, department chairpersons -- answer each question as it applies to your science department.**

36. To what degree is the unified science program implemented in your classroom?

____ (A) Fully implemented
____ (B) Strongly implemented
____ (C) Average implementation
____ (D) Weakly implemented
____ (E) Not implemented

37. Which of the following most accurately describes unified science as it is currently taught in your classroom.

____ (A) I do not teach unified science.
____ (B) I am preparing to teach unified science.
____ (C) I teach unified science and focus most of my attention on managing and organizing the course.
____ (D) I routinely teach unified science and make most changes to increase its impact on students.
____ (E) I teach unified science at a refined level and explore alternative and additional activities to maximize the involvement and learning of students.

38. Which of the following forms the primary basis of your science instruction? (Check One)

____ (A) Unified science taxonomies
____ (B) Unified science teacher guides
____ (C) Science textbooks
____ (D) Teacher's/student's background and interests
____ (E) Other sources (list) _____

**What percentage of time are each of the following the emphasis of instruction?** (Items 39 through 43)

39. Scientific facts

____ (A) Less than 20% of the time
____ (B) 20-40% of the time
____ (C) 40-60% of the time
____ (D) 60-80% of the time
____ (E) More than 80% of the time

40. Scientific concepts

____ (A) Less than 20% of the time
____ (B) 20-40% of the time
____ (C) 40-60% of the time
____ (D) 60-80% of the time
____ (E) More than 80% of the time

41. Scientific theories and laws of natural phenomenon

____ (A) Less than 20% of the time
____ (B) 20-40% of the time
____ (C) 40-60% of the time
____ (D) 60-80% of the time
____ (E) More than 80% of the time

42. The process of inquiry

____ (A) Less than 20% of the time
____ (B) 20-40% of the time
____ (C) 40-60% of the time
____ (D) 60-80% of the time
____ (E) More than 80% of the time

43. Scientific literacy

____ (A) Less than 20% of the time
____ (B) 20-40% of the time
____ (C) 40-60% of the time
____ (D) 60-80% of the time
____ (E) More than 80% of the time

44. What is the average length of a daily science lesson?

____ (A) 15 minutes or less
____ (B) 16-25 minutes
____ (C) 26-35 minutes
____ (D) 36-45 minutes
____ (E) more than 45 minutes

45. The amount of time allotted for daily unified science instruction should:

____ (A) be increased
____ (B) remain the same
____ (C) be decreased

**Which of the following do you use in teaching unified science?** (Items 46 through 54)

46. Teacher presentations

____ (A) Always
____ (B) Frequently
____ (C) Occasionally
____ (D) Seldom } Briefly
____ (E) Never } Explain_____

47. Textbook readings

____ (A) Always
____ (B) Frequently
____ (C) Occasionally
____ (D) Seldom } Briefly
____ (E) Never } Explain_____

48. Homework

____ (A) Always
____ (B) Frequently
____ (C) Occasionally
____ (D) Seldom } Briefly
____ (E) Never } Explain_____

49. Workbook or other supplementary activities.

____ (A) Always
____ (B) Frequently
____ (C) Occasionally
____ (D) Seldom } Briefly
____ (E) Never } Explain_____

50. Teacher laboratory demonstrations

____ (A) Always
____ (B) Frequently
____ (C) Occasionally
____ (D) Seldom } Briefly
____ (E) Never } Explain_____

51. Student laboratory activities

____ (A) Always
____ (B) Frequently
____ (C) Occasionally
____ (D) Seldom } Briefly
____ (E) Never } Explain_____

52. Learning stations

____ (A) Always
____ (B) Frequently
____ (C) Occasionally
____ (D) Seldom } Briefly
____ (E) Never } Explain_____

53. Independent work

____ (A) Always
____ (B) Frequently
____ (C) Occasionally
____ (D) Seldom } Briefly
____ (E) Never } Explain_____

54. Group/Individual projects

____ (A) Always
____ (B) Frequently
____ (C) Occasionally
____ (D) Seldom } Briefly
____ (E) Never } Explain_____

55. How many texts are required for you to teach Unified Science?

____ (A) None
____ (B) One
____ (C) Two
____ (D) Three
____ (E) More than three

56. How many of the P.L.O.'s you teach are covered by these texts?

____ (A) All
____ (B) Most
____ (C) About half
____ (D) Few
____ (E) None

**To what degree are textbooks available for the following types of students?** (Items 57 through 59)

57. Students with well developed reading skills

____ (A) Always
____ (B) Usually
____ (C) About half the time
____ (D) Seldom
____ (E) Never

58. Students with average reading skills

____ (A) Always
____ (B) Usually
____ (C) About half the time
____ (D) Seldom
____ (E) Never

59. Students with poorly developed reading skills

____ (A) Always
____ (B) Usually
____ (C) About half the time
____ (D) Seldom
____ (E) Never

60. Do you have copies of the Taxonomies of Objectives for the P.L.O.'s you teach?

____ (A) For all
____ (B) For most
____ (C) For half
____ (D) For few
____ (E) For none

61. Do you have copies of the Teacher's Guides for the P.L.O.'s you teach?

____ (A) For all
____ (B) For most
____ (C) For half
____ (D) For few
____ (E) For none

**Which of the following do you use as a source for instructional planning?** (Items 62 through 65)

62. Taxonomy of Objectives

____ (A) Always
____ (B) Frequently
____ (C) Occasionally
____ (D) Seldom } Briefly
____ (E) Never } Explain_____

63. Teacher's Guides

____ (A) Always
____ (B) Frequently
____ (C) Occasionally
____ (D) Seldom } Briefly
____ (E) Never } Explain_____

64. Textbooks

____ (A) Always
____ (B) Frequently
____ (C) Occasionally
____ (D) Seldom } Briefly
____ (E) Never } Explain_____

65. Other sources

____ (A) Always
____ (B) Frequently
____ (C) Occasionally
____ (D) Seldom } Briefly
____ (E) Never } Explain_____

66. Required unified science laboratory materials are

____ (A) Available in sufficient quantity
____ (B) Available in insufficient quantity
____ (C) Not available

67. Required unified science equipment is

____ (A) Available in sufficient quantity
____ (B) Available in insufficient quantity
____ (C) Not available

68. What is the condition of the required laboratory equipment?

____ (A) All equipment is in working order
____ (B) Most of the equipment is in working order
____ (C) About half of the equipment is in working order
____ (D) Most of the equipment is in need of repair or replacement
____ (E) All of the equipment is in need of repair or equipment

69. To what degree do the facilities provide for the full implementation of unified science?

____ (A) To a great degree
____ (B) To an adequate degree
____ (C) To an average degree
____ (D) To a little degree } Briefly
____ (E) Not at all } Explain_____

70. To what degree are science facilities designed to ensure the safety of persons and property?

____ (A) To a great degree
____ (B) To an adequate degree
____ (C) To an average degree
____ (D) To a little degree } Briefly
____ (E) Not at all } Explain_____

**To what degree does unified science program:**
(Items 71 through 80)

71. Provide for the educational needs of children K-10?

____ (A) To a great degree
____ (B) To an adequate degree
____ (C) To an average degree
____ (D) To a little degree } Briefly
____ (E) Not at all } Explain_____

72. Set realistic goals and objectives for the students?

____ (A) To a great degree
____ (B) To an adequate degree
____ (C) To an average degree
____ (D) To a little degree } Briefly
____ (E) Not at all } Explain_____

73. Set realistic goals and objectives for the teacher?

____ (A) To a great degree
____ (B) To an adequate degree
____ (C) To an average degree
____ (D) To a little degree } Briefly
____ (E) Not at all } Explain_____

74. Contribute to the total school program?

____ (A) To a great degree
____ (B) To an adequate degree
____ (C) To an average degree
____ (D) To a little degree } Briefly
____ (E) Not at all } Explain_____

75. Provide for articulation among P.L.O.'s so that the sequence of learning is free from gaps and unnecessary repetition?

____ (A) To a great degree
____ (B) To an adequate degree
____ (C) To an average degree
____ (D) To a little degree } Briefly
____ (E) Not at all } Explain_____

76. Provide for articulation among elementary, middle-junior high, and senior high school science?

____ (A) To a great degree
____ (B) To an adequate degree
____ (C) To an average degree
____ (D) To a little degree } Briefly
____ (E) Not at all } Explain_____

77. Provide for individual differences and program changes as students, teachers, and other staff members see the need?

____ (A) To a great degree
____ (B) To an adequate degree
____ (C) To an average degree
____ (D) To a little degree } Briefly
____ (E) Not at all } Explain_____

78. Provide for the common needs of students?

____ (A) To a great degree
____ (B) To an adequate degree
____ (C) To an average degree
____ (D) To a little degree } Briefly
____ (E) Not at all } Explain_____

79. Provide for the individual needs of students?

____ (A) To a great degree
____ (B) To an adequate degree
____ (C) To an average degree
____ (D) To a little degree } Briefly
____ (E) Not at all } Explain_____

80. Provide for the continuous progress of students?

____ (A) To a great degree
____ (B) To an adequate degree
____ (C) To an average degree
____ (D) To a little degree } Briefly
____ (E) Not at all } Explain_____

81. How important is it for students to complete all 21 proficiency levels to meet the objectives of the unified science program?

____ (A) Very important
____ (B) Somewhat important
____ (C) Slightly important } Briefly
____ (D) Not important } Explain_____

82. How would you rate your preparation to teach unified science?

____ (A) Excellent
____ (B) Satisfactory
____ (C) Unsatisfactory } Briefly
____ (D) Very poor } Explain_____

83. Overall to what degree do you accept unified science as an organizational and instructional approach to science?

____ (A) I endorse it completely
____ (B) I accept it in general
____ (C) I accept it with reservations
____ (D) It is questionable } Briefly
____ (E) It is unacceptable } Explain_____

84. Overall how successful have you been in teaching unified science?

____ (A) Very successful
____ (B) Usually successful
____ (C) Of average success
____ (D) Usually unsuccessful } Briefly
____ (E) Very unsuccessful } Explain_____

## SECTION IV

85. Please list each proficiency level (P.L.) and objective (P.L.O.) which you realistically plan to complete during this school year.

| P.L. | Unified Science P.L.O. Numbers |
|---|---|
| | |

86. What steps can be taken to improve the unified science program and its delivery?

87. What else would you like to share about unified science?

Thank you for completing this survey.

**SYNTHESIZED SUMMARY OF THE CONSULTANTS' REPORTS PORTION OF THE SCIENCE PROGRAM EVALUATION CONDUCTED BY THE RESEARCH OFFICE OF THE ANNE ARUNDEL COUNTY PUBLIC SCHOOLS.**

**Submitted By: Dr. J. David Lockard, Director, The International Clearinghouse on Science and Mathematics Curriculum Developments, University of Maryland, College Park, August 1981.**

This report is a synthesized summary of the reports from five consultants to the Science Program Evaluation conducted under the direction of Dr. Timothy R. Dangel, Coordinator of Research of the Anne Arundel County Public Schools. The five consultants, in addition to the writer of this report, were: Mr. Joseph Dasbach of the American Association for the Advancement of Science; Dr. Francis J. DiVesta of the Department of Counseling and Educational Psychology of The Pennsylvania State University; Dr. Bernard Gross, Director of Science of the Rochester, New York, Public Schools; Mrs. Constance Tate, Coordinator of Science of the Baltimore City Public Schools; and Dr. Leon Ukens of the Department of Physics of Towson State University. In addition to the written reports of the consultants a full-day session of oral presentations and discussions was held with all the consultants together to elaborate on and clarify their written reports to better prepare this summary. Any well expressed thoughts presented here should be credited to the five other consultants and any confusing statements or misinterpretations should be blamed on this writer.

In order to briefly summarize the much more detailed written reports, this synthesized version is divided into three sections. The first deals with what is felt to be the major strengths of the Anne Arundel County Unified Science Approach Curriculum. The second is directed to perceived weaknesses or possible shortcomings of the curriculum, or its implementation, as noted by the consultants. The third section is a set of suggested recommendations that the consultants would like to offer to the county for consideration and, hopefully, implementation. Further details on any of these items can be found in the original documents submitted by the consultants. All of us felt that the Unified Science Approach Curriculum was an admirable achievement of the Anne Arundel County Public Schools for the decade of the seventies. We also felt that it is highly commendable that such a complete and well structured evaluation is being made of this major school instructional activity.

When reading through the following sections, please note that the recommendations are designed to help overcome the perceived weaknesses of the curriculum.

Strengths of the Unified Science Approach:

1. It provides a systematic approach to program development and reflects an immense organizational effort of an academically and technically capable staff dedicated to excellence.

2. It provides for all formal science instruction for all the county's students at all levels.

3. It provides consistency of science topic coverage across the county system.

4. The attempt to develop a spiral approach is commendable and encourages recognition of the continuity of science.

5. The scheme for scientific literacy is a good starting base for a total science program.

6. The basic constructs and philosophical roots detailed in the first eight pages of the taxonomy are excellent beginnings and when properly implemented provide highly desirable directions.

7. The involvement of the local personnel in the development and growth of the curriculum is highly commendable and helps tailor its nature to the area locale as well as aiding in its later implementation.

8. The format as designed will facilitate revisions and up-dating as needed and has apparent flexibility for adaptation and change.

9. The curriculum as developed was an admirable achievement of the Anne Arundel County Public Schools for the decade of the seventies.

Perceived weaknesses of the Unified Science Approach:

1. There is a tremendous responsibility of the teachers to not only be highly trained in all the areas of science but to also be highly competent and creative in all phases of science instruction.

2. That the curriculum as now written does not live up to its stated goals of teaching science as an investigative process.

3. That there is too heavy an emphasis on subject matter content and scientific "facts" that are frequently open for change and reinterpretation.

4. That there is a lack of student involvement in the "processes of science" using the natural phenomena and science oriented investigative equipment.

5. That there may not be enough attention given to the development level of the learners.

6. That there is a lack of congruence between the program strategies and the curriculum materials provided.

7. That the hoped for individualization of instruction relies heavily on the teacher and is not properly reflected in the curriculum materials.

8. Many of the objectives as presently written are not stated in a form as to be measureable.

9. There is an overall predominance of the objective described in the taxonomy of objectives in the semester course taxonomies.

10. The basis of the pre-tests is not clear and the post-test interpretations leave too much area for interpretation by the teacher.

11. There is much attention given to the activities and the objectives and too little attention given to the pre-tests and the post-tests.

12. There is too much emphasis on verbal learning which when not meaningful leads to the traditional recitation mode of American education.

13. There is concern that after students have completed all the 21 proficiency levels they still may not be aware of the unifying themes.

14. The teacher's guides lack specificity in leading the reader to teaching the unifying themes, which are open to too much interpretation.

15. That there are an overwhelming number of objectives so that a single teacher might encounter over one thousand of them.

16. Many of the stated activities are not true science activities and leave little opportunity for students to use the processes of science.

17. There is too little emphasis on the discipline of reasoning inherent in the sciences and too little emphasis on how scientific knowledge is produced.

18. There is too little emphasis on possible careers in science and in science-related fields.

19. Much of the material does not reflect our present understanding of the state of the art and does not include recent breakthroughs.

Recommendations For Consideration and Appropriate Implementation:

1. That in-service training programs be continued and expanded with proper coverage of such topics as:

    A. Up-to-date science subject matter and how it can be integrated into the nature of unified science.

    B. How to best use the curriculum materials already prepared.

    C. Development of teacher questioning skills.

    D. The purpose and use of the unifying themes.

    E. Skills of teaching science from an "inquiry" approach and less from a "body of knowledge" approach.

    F. Furnish specific experiences with selected core activities.

2. That more attention has to be given to authentic "hands-on process-oriented" science student activities and less emphasis be given to verbal "parroting" of science information.

3. That more attention be given to the student going on beyond memorization and simple recall to a sense of inquiry and discovery, problem-solving, integration of scientific information and interpretation of data.

4. That there be more "open-ended" experiments and experiences added to the curriculum in which students carry out their observations and data collection on near-by materials that they actually physically interact with and not just see on paper or on film.

5. That a study be made of the materials to determine if the spiraling levels match up with the developmental levels of the students and that the various learning theories be applied as appropriate.

6. That there be less emphasis on "fill in the blank" workbooks and more emphasis put on the higher levels of Bloom's Taxonomy including application, analysis and synthesis of science subject materials.

7. That the anticipated goals of individualization still be pursued but that in addition to teacher workshop sessions on individualizing instruction there should be a rewriting of the materials to truly reflect student individualization activities and better "road maps".

8. That any of the objectives not presently measureable be rewritten in a form so that one can measure their accomplishments.

9. Other action verbs should be added to the Semester Course Objectives Taxonomies so that describe is no longer so dominate and that there be more use of compare and contrast.

10. Material should be added that explains that basis of the pre-tests and the post-tests should be rewritten so that there is less dependence on the teacher for their interpretation.

11. More attention should be given to the pre-tests and the post-tests so that they are geared to the objectives and be functional so that they allow the teacher to key individual students into related measureable objectives.

12. That any rewritten or newly written material have less emphasis on verbal learning and more on "doing science" rather than "reading about" or "listening to" science.

13. That serious consideration be given to the problems and benefits of curriculum coordination so that the unifying themes become self-evident to the students.

14. That the teacher's guides be made more specific and that this be particularly done in regard to the teaching of the unifying themes.

15. That considerable thought be given to reducing the total number of objectives that a student must meet by combining closely related ones and selecting only those that are considered highly desireable.

16. That more alternative activities be written to meet an objective and these activities be more science process oriented with more opportunity for true science investigation.

17. That any changes or added material strongly encourage the discipline of reasoning and the maximum of student creativity.

18. That there be a serious attempt at identifying science and science-related careers to students whenever appropriate with information on where to find additional information on each career.

19. There exists a need for a mechanism of continuous revision as well as for an immediate up-dating of the science content.